MP MASTER
MA24290

Goose Bay, CG.

INSTRUCTION MANUAL

FM-AM SIGNAL GENERATOR MODEL 103C & MODEL 103D

BOONTON
ELECTRONICS CORPORATION ROUTE 287, PARSIPPANY, NEW JERSEY 07054
TELEPHONE: 201 – 887-5110 TWX: 710-986-8241

WARRANTY

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to active devices that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty. Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

BOONTON
ELECTRONICS CORPORATION ROUTE 287, PARSIPPANY, NEW JERSEY 07054
TELEPHONE: 201 -- 887-5110 TWX: 710-986-8241

TABLE OF CONTENTS

SECTION I — INTRODUCTION

Paragraph		Page
1-1	Scope of Manual	1-1
1-4	Purpose and Use of Equipment	1-1
1-7	Options	1-4
1-10	Specifications	1-4
1-12	Outline Dimensions	1-4

SECTION II — OPERATION

Paragraph		Page
2-1	General	2-1
2-3	Installation	2-1
2-4	Unpacking	2-1
2-5	Mounting	2-1
2-6	Power Requirements	2-2
2-7	Cable Connections	2-2
2-8	Operating Controls, Indicators and Connectors	2-2
2-10	Power Application	2-7
2-12	Preliminary Check	2-7
2-14	Operating Procedures	2-8
2-15	General	2-8
2-16	Output Frequency Selection	2-8
2-17	Modulation Mode Selection	2-8
2-18	Adjustment of Modulation Levels	2-8
2-19	Adjustment of Output Level	2-9
2-20	Frequency Sweep Operation	2-9
2-21	Frequency Counter Operation	2-10
2-22	Phase Lock Operation	2-11
2-23	Application Notes	2-11
2-24	General	2-11
2-25	Impedance Matching	2-11
2-33	If Response	2-12
2-34	Phase Locking (Model 103C)	2-13
2-35	Non Harmonic Outputs	2-15
2-36	Visual Frequency Response Checks	2-15
2-37	Minimum Performance Checks	2-15
2-38	Test Equipment Required	2-15
2-39	Frequency Accuracy Check	2-16
2-40	Frequency Range Check	2-16
2-41	Vernier Tuning Range Check	2-16
2-42	Frequency Stability Check	2-16
2-43	Output Level Accuracy Check	2-17
2-44	Output Leveling Check	2-18
2-45	Output VSWR Check	2-19
2-46	Harmonic and Spurious Output Check	2-20
2-47	Modulation Oscillator Output Level and Distortion Checks	2-21
2-48	Modulation Oscillator Frequency Accuracy Check	2-21
2-49	FM Sensitivity Check	2-21
2-50	FM Deviation Accuracy Check	2-22
2-51	FM Distortion Check	2-22
2-52	FM Bandwidth Check	2-23
2-53	Incidental AM with FM Check	2-24
2-54	AM Sensitivity Check	2-25
2-55	AM Accuracy Check	2-25

SECTION II — OPERATION (Cont.)

Paragraph		Page
2-56	AM Distortion Check	2-26
2-57	AM Range Ratio and Tracking Checks	2-27
2-58	AM Bandwidth Check	2-27
2-59	Incidental PM with AM Check	2-28
2-60	Residual FM Check	2-28
2-61	Sweep Tuning Range Check	2-29
2-62	Sweep Accuracy Check	2-29
2-63	Frequency Counter Sensitivity Check	2-30
2-64	RF Leakage Check	2-31

SECTION III — THEORY OF OPERATION

Paragraph		Page
3-1	General	3-1
3-6	Simplified Block Diagram	3-1
3-7	General	3-1
3-8	VFO Circuits	3-1
3-10	Phase Lock Circuits (Model 103D Only)	3-2
3-11	Sweep Oscillator Circuits	3-2
3-13	Output-Frequency Selection Circuits	3-3
3-14	Intensity Marker Circuits	3-3
3-15	Output Circuits	3-3
3-19	Modulation Circuits	3-3
3-25	Frequency Counter Circuits	3-8
3-26	Power Supply Circuits	3-4
3-27	Detailed Theory of Operation, VFO Circuits	3-5
3-31	Detailed Theory of Operation, Phase Lock Circuits (Model 103D)	3-6
3-38	Detailed Theory of Operation, Sweep Oscillator Circuits	3-11
3-42	Detailed Theory of Operation, Output-Frequency Selection Circuits	3-11
3-43	General	3-11
3-44	Frequency Divider Printed Circuit Board	3-11
3-49	Driver Printed-Circuit Board	3-12
3-54	Detailed Theory of Operation, Intensity Marker Circuits	3-17
3-57	Detailed Theory of Operation, Output Circuits	3-17
3-66	Detailed Theory of Operation, Modulation Circuits	3-18
3-67	General	3-18
3-68	Internal FM	3-18
3-73	External FM	3-25
3-74	Internal AM	3-25
3-78	External AM	3-26
3-79	Frequency Sweep	3-26
3-82	CW	3-27
3-83	Detailed Theory of Operation, Frequency Counter Circuits	3-27
3-92	Detailed Theory of Operation, Power Supply Circuits	3-28

SECTION IV — MAINTENANCE

Paragraph		Page
4-1	General	4-1
4-3	Test Equipment Required	4-1
4-5	Preliminary Inspection	4-1
4-6	Visual Check	4-1
4-7	Power Suply Check	4-1
4-8	Major Assembly Location	4-1
4-10	Trouble Localization	4-1

SECTION IV — MAINTENANCE (Cont.)

Paragraph		Page
4-11	Symptomatic Troubleshooting	4-1
4-12	Systematic Troubleshooting	4-2
4-13	Frequency Instability Problem Troubleshooting	4-2
4-14	Alignment and Adjustment Procedures	4-7
4-15	General	4-7
4-16	Test Equipment Required	4-7
4-17	Power Supply Adjustment and Check	4-7
4-18	Modulation Oscillator	4-11
4-19	Frequency Accuracy Adjustment	4-11
4-20	FM Tracking and VFO Alignment	4-20
4-21	Band 11 Oscillator and Filter Adjustments	4-21
4-22	RF Output Adjustments	4-24
4-23	Modulation Adjustments	4-24
4-24	Sweep Oscillator Adjustments	4-29
4-25	RAMP Generator Frequency Adjustment	4-30
4-26	Intensity Marker 10 point MHz ±300 kHz Deviation Adjustment	4-30
4-27	Intensity Marker 10 point MHz ±1 MHz Deviation Adjustment	4-32
4-28	Intensity Marker 98 MHz ±10 MHz Deviation Adjustment	4-32
4-29	Parts Removal	4-33
4-30	General	4-33
4-31	VFO Inductuner Removal	4-33
4-32	Tuning Control Drive, Dial Cord Replacement	4-33
4-33	Varactor Tracking Capacitor, Dial Cord Replacement	4-33
4-34	Inductuner Cleaning and Lubrication	4-33
4-36	Voltage Measurements	4-34

SECTION V — PARTS LIST

Paragraph		Page
Table of Replaceable Parts		5-1

SECTION VI — SCHEMATIC DIAGRAMS

Paragraph		Page
Schematic Diagrams		6-1

LIST OF ILLUSTRATIONS

Figure		Page
1-1	FM-AM Signal Generator, Model 103D	vi
1-2	Spectrum Comparison, Model 103D and Crystal Oscillator	1-1
1-3	Stability Characteristics of Production Model	1-2
1-4	LED Frequency Display	1-3
1-5	FM/AM Modulation Characteristics	1-3
1-6	Outline Dimensions	1-9
2-1	Packaging Diagram	2-1
2-2	Signal Generator (Model 103D) Front View	2-3
2-3	Signal Generator (Model 103D) Rear View	2-3
2-4	Impedance Matching Network for Output Load Impedance Higher than 50 Ohms	2-11
2-5	Impedance Matching Network for Output Load Impedance Lower than 50 Ohms	2-12
2-6	Generator Open Circuit Source Voltage	2-13
2-7	Matched 6 dB Pad	2-13
2-8	Toroidal Balun Construction Details	2-13
2-9	300 Ohm Balanced Matching Network	2-13
2-10	Wideband Response 1:1 Toroidal Balun	2-13
2-11	Narrowband Response 4:1 Coaxial Balun	2-14

LIST OF ILLUSTRATIONS (Cont.)

Figure		Page
2-12	If Response Measurement, Typical Equipment Connection	2-14
2-13	Phase Locking of Model 103C, Typical Equipment Connection	2-14
2-14	Frequency Response Checks, Typical Equipment Connection	2-15
2-15	Frequency Stability Check, Test Setup	2-17
2-16	Output Level Accuracy Check, Test Setup	2-19
2-17	VSWR Check, Test Setup	2-20
2-18	FM Sensitivity Check, Test Setup	2-22
2-19	FM/AM Distortion Check, Test Setup	2-23
2-20	FM Bandwidth Check, Test Setup	2-24
2-21	Incidental AM with FM Check, Test Setup	2-25
2-22	AM Sensitivity Check, Test Setup	2-25
2-23	AM Bandwidth Check, Test Setup	2-27
2-24	Incidental PM with AM Check, Test Setup	2-29
2-25	Residual FM Check, Test Setup	2-29
2-26	Frequency Counter Sensitivity Check, Test Setup	2-30
3-1	Simplified Block Diagram	3-2
3-2	VFO Circuits (Model 103D), Detailed Block Diagram	3-5
3-3	Phase Lock Circuits (Model 103D), Detailed Block Diagram	3-7
3-4	Sweep Oscillator Circuits, Detailed Block Diagram	3-9
3-5	Frequency Divider Printed Circuit Board A13, Detailed Block Diagram	3-13
3-6	Driver Printed Circuit Board A8, RF Signal Processing Circuits, Detailed Block Diagram	3-15
3-7	Intensity Marker Printed Circuit Board A6, Detailed Block Diagram	3-19
3-8	Output Circuits, Detailed Block Diagram	3-21
3-9	Modulation Circuits, Detailed Block Diagram	3-23
3-10	Frequency Counter Circuits, Detailed Block Diagram	3-31
4-1	Signal Generator, Top View with Cover Shields Removed	4-4
4-2	Signal Generator, Bottom View with Cover Shields Removed	4-5
4-3	Intensity Marker Waveform Time Relationships	4-31
4-4	Tuning Control Drive, Dial Cord Installation	4-34
4-5	Varactor Tracking Capacitor, Dial Cord Installation	4-34
6-1	Main Frame A1, Model 103C, Schematic Diagram (Sheet 1 of 2)	6-3
6-1	Main Frame A1, Model 103D, Schematic Diagram (Sheet 2 of 2)	6-5
6-2	Display PCB A2, Schematic Diagram	6-7
6-3	Meter PCB A3, Schematic Diagram	6-9
6-4	VFO, Schematic Diagram	6-11
6-5	Buffer Amplifier PCB A4, Schematic Diagram	6-13
6-6	RF Housing A5, Model 103C, Schematic Diagram	6-15
6-7	RF Housing A5, Model 103D, Schematic Diagram	6-17
6-8	Intensity Marker PCB A6, Schematic Diagram	6-19
6-9	Output PCB A7, Schematic Diagram	6-21
6-10	Driver PCB A8, Schematic Diagram	6-23
6-11	HF Filter PCB A9, Schematic Diagram	6-25
6-12	Prescaler PCB A10, Schematic Diagram	6-27
6-13	Phase Lock Divider PCB A11, Model 103D, Schematic Diagram	6-29
6-14	Frequency Divider PCB A13, Schematic Diagram	6-31
6-15	Power Supply PCB A14, Schematic Diagram	6-33
6-16	Display Time Base PCB A16, Schematic Diagram	6-35
6-17	Modulation PCB A41, Schematic Diagram	6-37
6-18	Phase Lock Master PCB, Model 103D, Schematic Diagram	6-39
6-19	Phase Lock Time Base PCB, Model 103D Schematic Diagram	6-41
6-20	Phase Detector PCB, Model 103D, Schematic Diagram	6-43
6-21	Phase Lock Counter PCB, Model 103D, Schematic Diagram	6-45

LIST OF TABLES

Table		Page
1-1	Performance Specifications	1-5
2-1	Operating Controls, Indicators and Connectors	2-4
2-2	Intensity marker Specifications	2-10
2-3	Test Equipment List	2-15
4-1	Test Equipment List	4-2
4-2	Power Supply Check	4-3
4-3	Symptomatic Troubleshooting Chart	4-6
4-4	Systematic Troubleshooting Chart, VFO Circuits	4-8
4-5	Systematic Troubleshooting Chart, Output Frequency Selection Circuits	4-9
4-6	Systematic Troubleshooting Chart, Sweep Oscillator Circuits	4-12
4-7	Systematic Troubleshooting Chart, Modulation Circuits	4-13
4-8	Systematic Troubleshooting Chart, Output Circuits	4-17
4-9	Systematic Troubleshooting Chart, Frequency Counter Circuits	4-22
4-10	Systematic Troubleshooting Chart, Phase Lock Circuits	4-25
4-11	Systematic Troubleshooting Chart, Intensity Marker Circuits	4-27
4-12	DC Voltages, Display PCB A2	4-35
4-13	DC Voltages, Meter PCB A3	4-35
4-14	DC Voltages, Intensity Marker PCB A6	4-35
4-15	DC Voltages, Output PCB A7	4-36
4-16	DC Voltages, Driver PCB A8	4-36
4-17	DC Voltages, Prescaler PCB A10	4-36
4-18	DC Voltages, Phase Lock Divider PCB A11	4-37
4-19	DC Voltages, Frequency Divider PCB A13	4-37
4-20	DC Voltages, Power Supply PCB A14	4-37
4-21	DC Voltages, Display Time Base PCB A16	4-38
4-22	DC Voltages, Modulation PCB A41	4-38
4-23	DC Voltages, Phase Lock Time Base PCB	4-39
4-24	DC Voltages, Phase Detector PCB	4-39
4-25	DC Voltages, Phase Lock Counter PCB	4-40

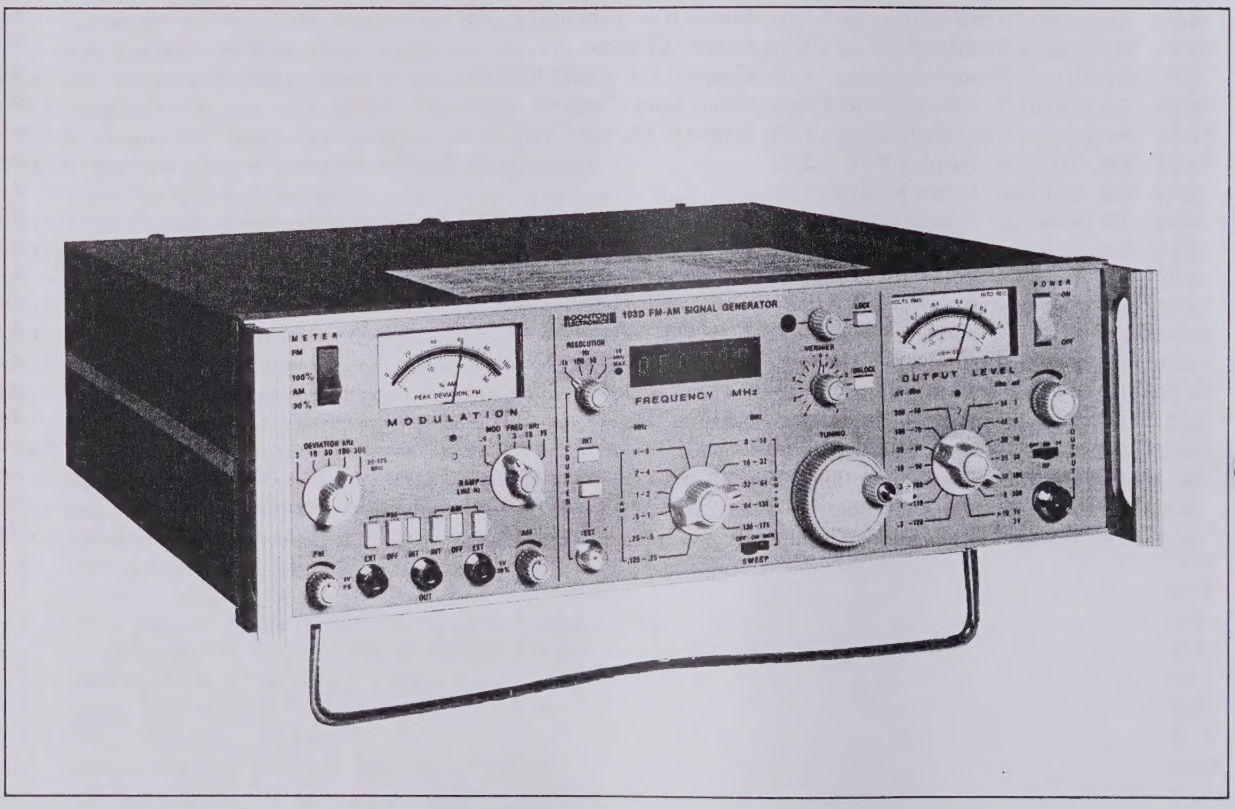


Figure 1-1 FM-AM Signal Generator, Model 103D

SECTION I
INTRODUCTION

1-1. SCOPE OF MANUAL.

1-2. This instruction manual provides descriptive data, operating instructions, theory of operation, maintenance instructions, and a parts list for Model 103C and Model 103D FM-AM Signal Generators. (See Figure 1-1.) The signal generators are manufactured by Boonton Electronics Corporation, Parsippany, New Jersey.

1-3. The Model 103C and Model 103D signal generators are identical, except for the addition of a phase locking loop in the Model 103D signal generator. All information provided in this instruction manual applies to both models, except where specifically stated otherwise.

1-4. PURPOSE AND USE OF EQUIPMENT.

1-5. The signal generator is a wide range, highly versatile, precision, solid-state instrument with features and performance characteristics especially suitable for laboratory design, production testing, and field testing applications. Design features enable use of the signal generator as an AM signal generator, an FM signal generator, a combined FM-AM signal generator, a combined sweep and marker signal generator, or a frequency counter, thereby reducing the need for additional test equipment in many test applications. The signal generator covers a frequency range of 0.125 MHz to 175 MHz in 11 bands. Human engineering considerations have been emphasized in both the mechanical and electrical design of the instrument. The result is an instrument that is convenient and easy to use, despite its great versatility. Among the outstanding design features are:

a. **Spectral Purity.** The spectral purity of the signal generator is comparable to that of a crystal oscillator. (See Figure 1-2.) All output frequencies are derived from the output of an inductively tuned VFO with inherently low microphonism. Output frequencies on bands 1 through 9 are derived through frequency division of the VFO output frequencies; output frequencies on band 11 are derived by heterodyning one half the VFO output frequencies with the output of an internal, crystal controlled, 106 MHz oscillator. Appropriate filters are automatically switched into the fre-

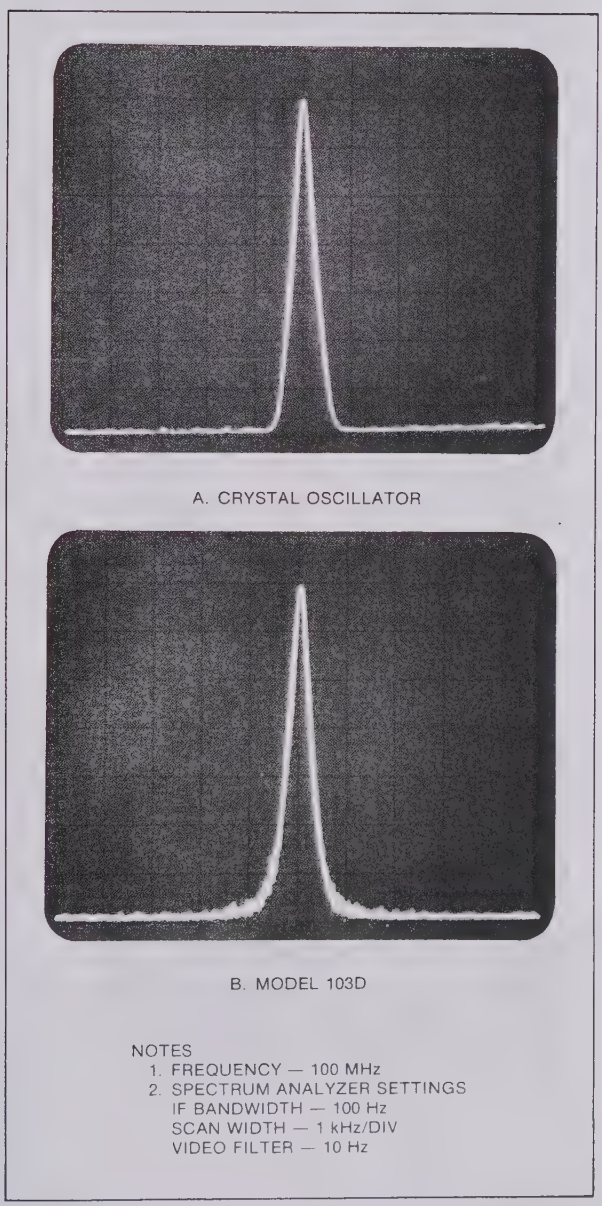


Figure 1-2 Spectrum Comparison, Model 103D and Crystal Oscillator

quency generating circuits to suppress spurious frequencies. The suppression of harmonics and other spurious frequencies provides assurance to the user that test results obtained using the instrument will reflect selected test parameters only; erroneous test indications resulting from spurious frequencies are unlikely.

b. **Stability.** The signal generator exhibits outstanding stability characteristics, both short-term and long-term. The band switching technique used in the instrument eliminates a major source of instability and allows immediate use of each band without further stabilization. Design specifications limit drift to a maximum of 10 ppm/10 minutes after 2 hours warmup on all bands. The phase lock feature *(Model 103D only)* further reduces drift to 0.2 ppm/hour after 1 hour warmup, and to less than 0.05 ppm/hour after 4 hours warmup. Actual drift of a production model is shown in Figure 1-3. The stability of the signal generator minimizes the need for extended, time-consuming warmup periods and for repeated readjustment of the output frequency during use.

c. **LED Frequency Display.** The output frequency of the signal generator is continuously displayed during use by means of a 6-digit LED display. The elimination of a tuning dial, with its recalibration problems and inherent reading uncertainty, removes a major source of operator error. The LED display provides clear, unambiguous readings with selectable resolution, thereby minimizing the possibility of misinterpretation. (See Figure 1-4.) Resolution of 1 Hz (bands 1 through 7 only), 10 Hz, 100 Hz, or 1 kHz can be selected by means of a front-panel switch.

d. **FM/AM Modulation Capabilities.** The signal generator is the ideal instrument for a wide variety of test applications because of its flexible modulation capabilities. FM (bands 7 through 11 only) and AM (all bands), using either internal or external modulation signals, can be used either singly or simultaneously. FM deviation is calibrated to an exceptionally wide 300 kHz on bands 9 through 11, and to 100 kHz on bands 7 and 8. The FM bandwidth extends from DC to 200 kHz in the unlocked mode. In the phase locked mode (Model 103D only), the FM bandwidth extends from 50 Hz to 200 kHz. Deviation is adjustable, metered, and constant with band and frequency changes. Distortion, and residual and incidental FM are extremely low; therefore, the signal generator is an excellent signal source for both wide-band measurements and narrow-band applications. AM is adjustable to 100 percent at output levels to 2 volts (50 percent at 3 volts output) with low distortion (typically less than 3 percent Total Harmonic Distortion at 80 percent modulation). The AM bandwidth extends from DC to 5 kHz on band 1, to 10 kHz on bands 2 and 3, and to 20 kHz on bands 4 through 11.

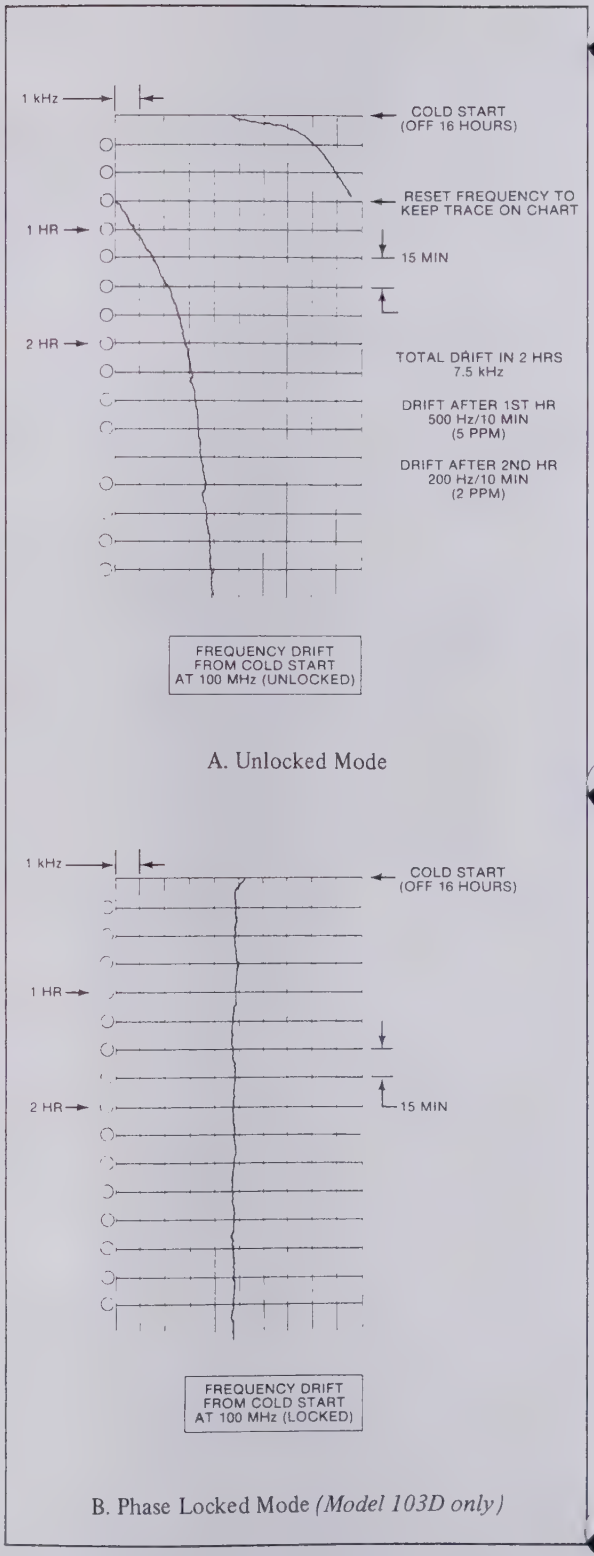
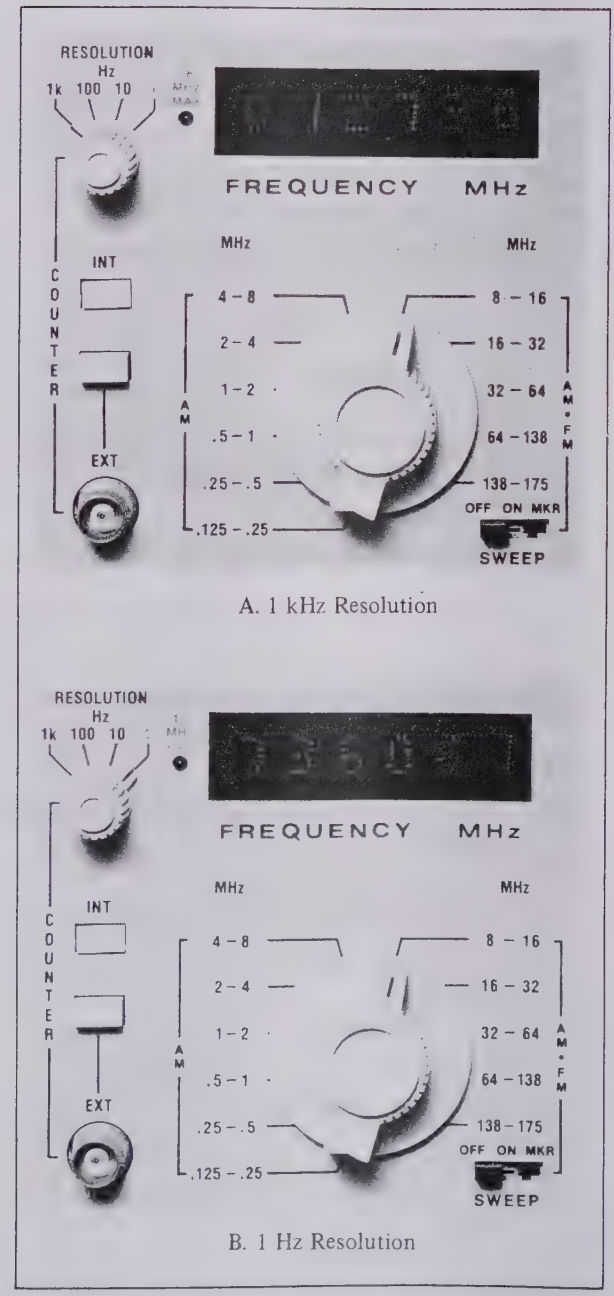


Figure 1-3 Stability Characteristics of Production Model

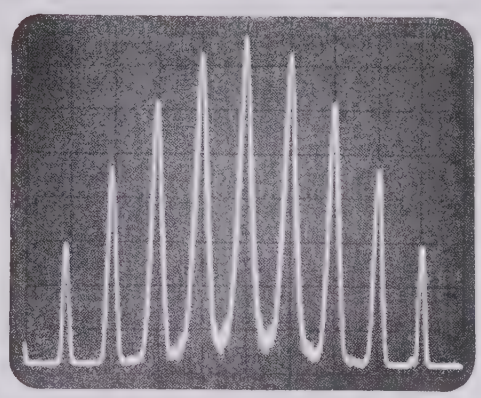
e. **Frequency Sweeping Capability.** Laboratory design, production testing, and many other test functions can be expedited through use of a sweep signal generator. Frequency sweep capabilities are incorporated into the signal generator for five of the most commonly used IF frequencies. Maximum sweep widths vary from ±30 kHz to ±10 MHz (refer to Table 1-1), and the sweep width is continuously adjustable within the maximum sweep width limits.



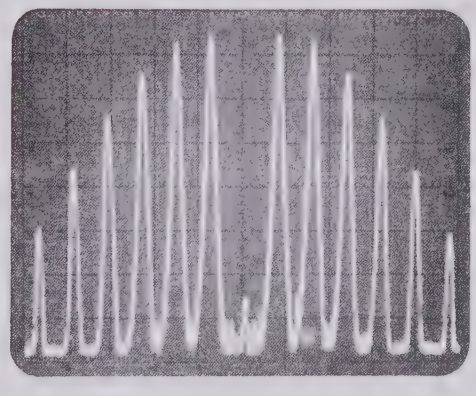
A. 1 kHz Resolution

B. 1 Hz Resolution

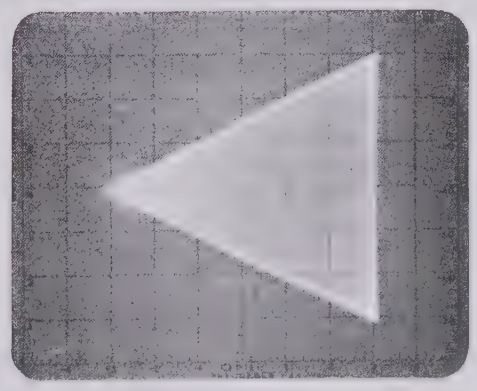
Figure 1-4 LED Frequency Display



A. FM SIDEBANDS
MODULATION FREQ — 20 kHz
FM DEVIATION — 22.5 kHz PEAK



B. FM WITH CARRIER AT FIRST BESSEL ZERO
MODULATION FREQ — 41.58 kHz
FM DEVIATION — 100 kHz PEAK
MODULATION INDEX — 2.4048



C. 100% AM TRAPEZOID
FREQ — 105 MHz
MODULATION FREQ — 3 kHz
OUTPUT LEVEL — +10 dBm

Figure 1-5 FM/AM Modulation Characteristics

A separate, tuneable sweep oscillator is used in the signal generator for the frequency sweep function. The center frequency can be accurately set using the LED display. The VFO can be used simultaneously to provide an intensity marker signal for frequency sweep operation on the 10.7 MHz and 98 MHz ranges only. The drive signal for the frequency sweep circuits can be either an internally generated 50-60 Hz ramp or an externally supplied 10 Hz to 1 kHz drive signal. The internal drive signal is available at a front panel connector for synchronization of an oscilloscope. Sweep output is through the normal output connector of the signal generator, and the sweep output can be monitored, leveled, and adjusted in the same manner as the normal RF output of the signal generator.

f. **Automatic Leveling.** The RF output of the signal generator is maintained within ±0.5 dB of the operator established level in all operating modes by means of an automatic leveling loop. Once the desired output level has been established, frequency changes and modulation of the signal generator output can be accomplished without affecting the output level, thereby simplifying operation.

g. **Frequency Counter Capability.** The signal generator uses an internal frequency counter to produce the LED frequency display. In order to extend the versatility of the instrument, provisions are included to permit use of the frequency counter circuits for frequency measurements of external signals as well. When using the signal generator in a test setup with other signal sources, the need for a separate frequency counter is thereby eliminated. Frequencies within the range of 5 Hz to 175 MHz can be measured. Resolution of 1 Hz (for frequencies up to 16 MHz only), 10 Hz, 100 Hz, or 1 kHz can be selected. Sensitivity of the frequency counter is greater than 100 millivolts for frequencies up to 175 MHz.

1-6. The features described in the preceding paragraph, together with those specified in Table 1-1, make the signal generator particularly useful for design, production line, and field testing in the broadcast-entertainment, communications, avionics, and public-service broadcasting fields. Because of its wide frequency range and versatility, the signal generator is also an excellent instrument for laboratory applications.

1-7. OPTIONS.

1-8. Several standard options are currently available. These options are:

Option No.	Description
-01	Rear RF output connector
-02	Special modulation frequencies (5 max.)
-04	Fused RF output with 10 spare fuse elements
-05	High Z AM input (10 kΩ)
-06	High Z FM input (10 kΩ)
-07	High Z AM and FM inputs (10 kΩ)
-08	External clock input
-13	75 μs pre-emphasis in FM channel
-15	CB modulator meter marks, 6.75 and 20.25 kHz
-16	Special sweep ranges
-17	75 Ω RF output impedance
-18	FM on band 6 (30 kHz maximum)
-19	Low distortion FM (88-108 MHz)

1-9. Inquiries regarding special applications of the signal generator to specific customer requirements are invited. Direct such inquiries to the Applications Engineering Department of Boonton Electronics Corporation.

1-10. SPECIFICATIONS.

1-11. Pertinent performance specifications for the signal generator are listed in Table 1-1.

1-12. OUTLINE DIMENSIONS.

1-13. Outline dimensions of the signal generator are shown in Figure 1-6.

TABLE 1-1. PERFORMANCE SPECIFICATIONS

Parameter	Specifications
OUTPUT FREQUENCY	
Range	0.125 MHz to 175 MHz in 11 bands: Band 1 – 0.125 MHz to 0.25 MHz Band 2 – 0.25 MHz to 0.5 MHz Band 3 – 0.5 MHz to 1 MHz Band 4 – 1 MHz to 2 MHz Band 5 – 2 MHz to 4 MHz Band 6 – 4 MHz to 8 MHz Band 7 – 8 MHz to 16 MHz Band 8 – 16 MHz to 32 MHz Band 9 – 32 MHz to 64 MHz Band 10 – 64 MHz to 138 MHz Band 11 – 138 MHz to 175 MHz
Accuracy	±(resolution + 1 ppm) at 15°C to 35°C after 1 hour
Resolution	Selectable; 1 Hz (bands 1 through 7 only), 10 Hz, 100 Hz, or 1 kHz
Display	6-digit LED
Stability:	
Unlocked	Drift less than 10 ppm/10 minutes after 2 hours
Phase Locked *(Model 103D only)*	Drift less than 0.2 ppm/hour after 1 hour, less than 0.05 ppm/hour after 4 hours
Fine Tuning:	
Unlocked	Electronic vernier, range of approximately 250 ppm at band center on bands 1 through 10, and approximately 80 ppm at band center on band 11
Phase Locked *(Model 103D only)*	Electronic vernier, approximate range of 40 ppm on bands 1 through 10, and 14 ppm on band 11
RF OUTPUT:	
Power Level:	
Normal	-130 dBm to +13 dBm (0.07 microvolt to 1 volt into 50 ohms)
High	+23 dBm (3 volts) on all bands, with restricted AM above +20 dBm
Attenuator	13 steps of 10 dB/step plus variable 13 dB calibrated on output meter
Accuracy	Band 1: ±(1.5 dB + 0.1 dB/10 dB step*) Bands 2-11: ±(1 dB + 0.1 dB/10 dB step*) Band 11 with 04 option: ±1.5 dB + 0.1 dB/10 dB step* *Maximum cumulative error 1 dB
Leveling	±0.5 dB across each band (±0.8 dB on band 11 with 04 option)
Impedance	50 ohms, with VSWR less than 1.3 at levels below 0 dBm
RF Interrupt	Isolation greater than 50 dB (at 0 dB on output meter); greater than 30 dB in sweep mode

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications
SPECTRAL PURITY (at output vernier settings between +3 and -10 dB at levels to +20 dBm):	
Spurious Outputs	Harmonics (all bands), -30 dB Non-harmonics (bands 1 through 10), -60 dB (at 0 dB on output meter) Mixing products (band 11), -30 dB (at 0 dB on output meter)
Residual FM	Less than 20 Hz in 20 Hz to 15 kHz post detection bandwidth on all bands
SSB Total Noise	125 dB/Hz at 20 kHz offset
Noise Floor	135 dB/Hz below carrier
RF Leakage	Less than 3 microvolts from any surface, measured with 2-turn 1-inch diameter loop into 50-ohm receiver
FREQUENCY MODULATION:	
Maximum Deviation	100 kHz peak, bands 7 and 8; 300 kHz peak, bands 9 through 11
Ranges	3 kHz, 10 kHz, 30 kHz, 100 kHz, and 300 kHz peak fs, metered by true peak reading meter; red markings at 22.5 kHz and 75 kHz
Accuracy	±7% fs
Bandwidth:	
Unlocked	DC to 200 kHz
Phase Locked *(Model 103D only)*	50 Hz to 200 kHz
Distortion:	
THD at 100 kHz Deviation	Band 7, 2.0%; band 8, 1.0%; band 9, 0.5%; band 10, 0.3%; band 11, 0.5%
THD at 75 kHz Deviation	Band 10, 0.2% (88 to 108 MHz)
Incidental AM with FM	Less than 0.25% at 100 kHz deviation (1 kHz rate)
Stereo Separation	46 dB minimum (50 Hz to 15 kHz rates), band 10
External Modulation Input	1.0 volt rms, nominal, into 600 ohms for fs deviation
AMPLITUDE MODULATION:	
Percent	0 to 100% for output levels of +20 dBm and below at output vernier settings between +3 and -10 dB
Calibrated Ranges	30% and 100% fs, true peak reading meter
Accuracy	±(1% AM + 7% of reading) to 80% AM at 1 kHz
Bandwidth	DC to 5 kHz on band 1, DC to 10 kHz on bands 2 and 3; DC to 20 kHz on bands 4 through 11
Distortion (at 1 kHz Modulation Rate)	At 30% AM, <1% THD on all bands At 80% AM, <3% THD on bands 3 – 11 (to +13 dBm) <5% THD on bands 1 and 2, bands 3-11 (to +20 dBm)

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications
Demodulated AM	0.25 volt for 30% AM at +10 dBm nominal
Incidental PM with AM	Less than 0.2 radian peak at 30% AM
Incidental FM with AM	Peak incidental PM multiplied by modulation rate
External Modulation Input	1 volt rms, nominal, into 600 ohms for 30% AM
INTERNAL MODULATION OSCILLATORS:	
Fixed Frequencies, Standard	400 Hz, 1 kHz, 3 kHz, 10 kHz, and 19 kHz sine wave; 50-60 Hz ramp (line sync)
Fixed Frequencies, Optional	Up to five in range of 20 Hz to 100 kHz may be specified
Output:	
Sine Wave	1 volt rms nominal into 600 ohms
Ramp	5 volts peak-to-peak nominal into 10K ohms
Sine Wave Distortion	Less than 0.2% THD
Sine Wave Frequency Accuracy	±3%
FREQUENCY SWEEP:	
Ranges and Maximum Sweep Widths	f_0 / Maximum Sweep Width / Intensity Marker 262 kHz / ±30 kHz / No 455 kHz / ±30 kHz / No 1.2 MHz / ±100 kHz / No 10.7 MHz / ±1 MHz / Yes 98 MHz / ±10 MHz / Yes
Drive:	
Internal	50-60 Hz ramp (line sync)
External	10 Hz to 1 kHz rate, using FM input connector
Output Level	-130 dBm to +13 dBm (0.07 microvolt to 1 volt into 50 ohms), +23 dBm (3.16 volts) in high level mode
Attenuator	13 steps of 10 dB/step plus variable 13 dB calibrated on output meter (meter scaled 0 to 3 volts in high level mode)
Accuracy	Band 1 : ±(1.5 dB + 0.1 dB/10 dB step*) Bands 2-10: ±(1 dB + 0.1 dB/10 dB step*) *Maximum cumulative error 1 dB
Leveling	±0.5 dB across each band
Output Impedance	50 ohms, with VSWR less than 1.3 below 0 dBm
Harmonics	-25 dB
Marker Pulse	+4 volts peak, 60 microsecond width
EXTERNAL FREQUENCY COUNTER:	
Frequency Range	5 Hz to 175 MHz
Sensitivity	Greater than 100 millivolts

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications
Input Impedance	1 megohm shunted by 90 pF of capacitance
Display	6-digit LED
Resolution	Selectable; 1 Hz (5 Hz to 16 MHz only), 10 Hz, 100 Hz, or 1 kHz
Reference Accuracy	Less than ±1 ppm, 15°C to 35°C
Ageing	3×10^{-9}/day
Maximum Input	20 volts rms
PHASE LOCK *(Model 103D only)*:	
Reference Oscillator:	
Frequency	1 MHz
Drift	Less than 0.05 ppm/hour after 4 hour warmup; less than 2 ppm/year
External Output	1 volt rms nominal into 1000 ohms
External Reference Input:	
Frequency	1 MHz
Level	0.2 volt to 5 volts rms into 1000 ohms
GENERAL:	
Power	Voltage taps to accomodate 100, 120, 220, or 240 volts ±10%, 50 to 400 Hz; 70 volt-amperes at 50 Hz
Dimensions	5.22" H x 17.66" W x 19.46"D (overall)
Weight	103C, 30 lbs. (13.6 kg); 103D, 40 lbs. (18.2 kg)
Temperature Range	0°C to 55°C operating
ACCESSORIES AVAILABLE:	
103-1A 5 Ω Impedance Transformer	
Frequency Range	0.2 to 2.0 MHz
Loss	10.0 dB±0.25 dB
VSWR:	1.3 to 1, maximum
Connectors	50 Ω BNC male, 5 Ω BNC female
Input Power	1 watt, max.
103-2A 75 Ω Impedance Transformer	
Frequency Range	.125 to 175 MHz
Loss	0 dB ±0.3 dB
VSWR	1.2, 500 kHz – 110 MHz; 1.5, 125 kHz – 500 kHz and 110 MHz – 175 MHz
Connectors	BNC Female
Input Power	1 watt max.

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications
103-3A 300 Ω (balanced) Impedance Transformer	
Frequency Range	0.5 – 110 MHz
Loss	0 dB ±0.75 dB
VSWR	1.5
Connectors	BNC Female; 300 Ω twin lead with spade lugs
Input Power	1 watt max.
Rack Mounting Flanges:	Furnished at no charge on request

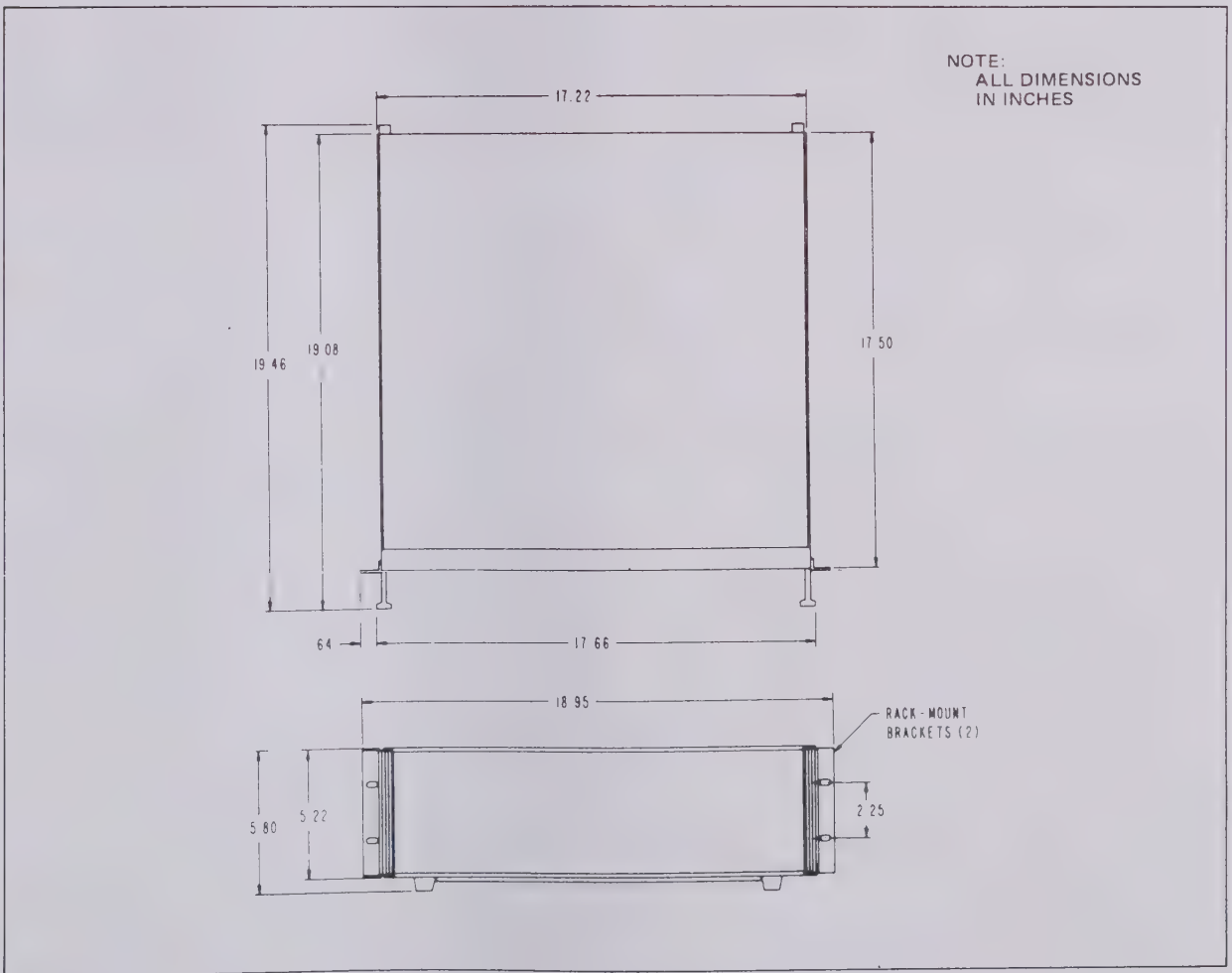


Figure 1-6 Outline Dimensions

SECTION II
OPERATION

2-1. GENERAL.

2-2. This section provides instructions for the installation and operation of the signal generator. Although the design of the signal generator emphasizes ease of use, it is recommended that the operator familiarize himself with the material in this section before attempting to operate the instrument; otherwise, the full capabilities of the signal generator may not be realized.

2-3. INSTALLATION.

2-4. **Unpacking**. The signal generator is shipped complete and is ready for use upon receipt. Packaging details are shown in Figure 2-1. Unpack the instrument from its shipping container and inspect it for damage that may have occurred during shipment. Check that all operating controls operate over their full range without binding.

NOTE

Save the packing material and container for possible use in reshipment of the signal generator.

2-5. **Mounting**. For bench mounting, choose a clean, sturdy, uncluttered mounting surface. See Figure 1-6 for space requirements. For rack mounting, an accessory rack mounting kit is available. It consists of two angle mounting brackets, four 8-32 binding head screws, and four lockwashers. To rack mount the signal generator, proceed as follows:

a. The signal generator cabinet has one slotted handle at each end of the front panel. On the outside surfaces of these handles, where they join the cabinet, are two strips of green pressure-sensitive tape. Remove or perforate this tape to expose the tapped mounting holes for the angle mounting brackets.

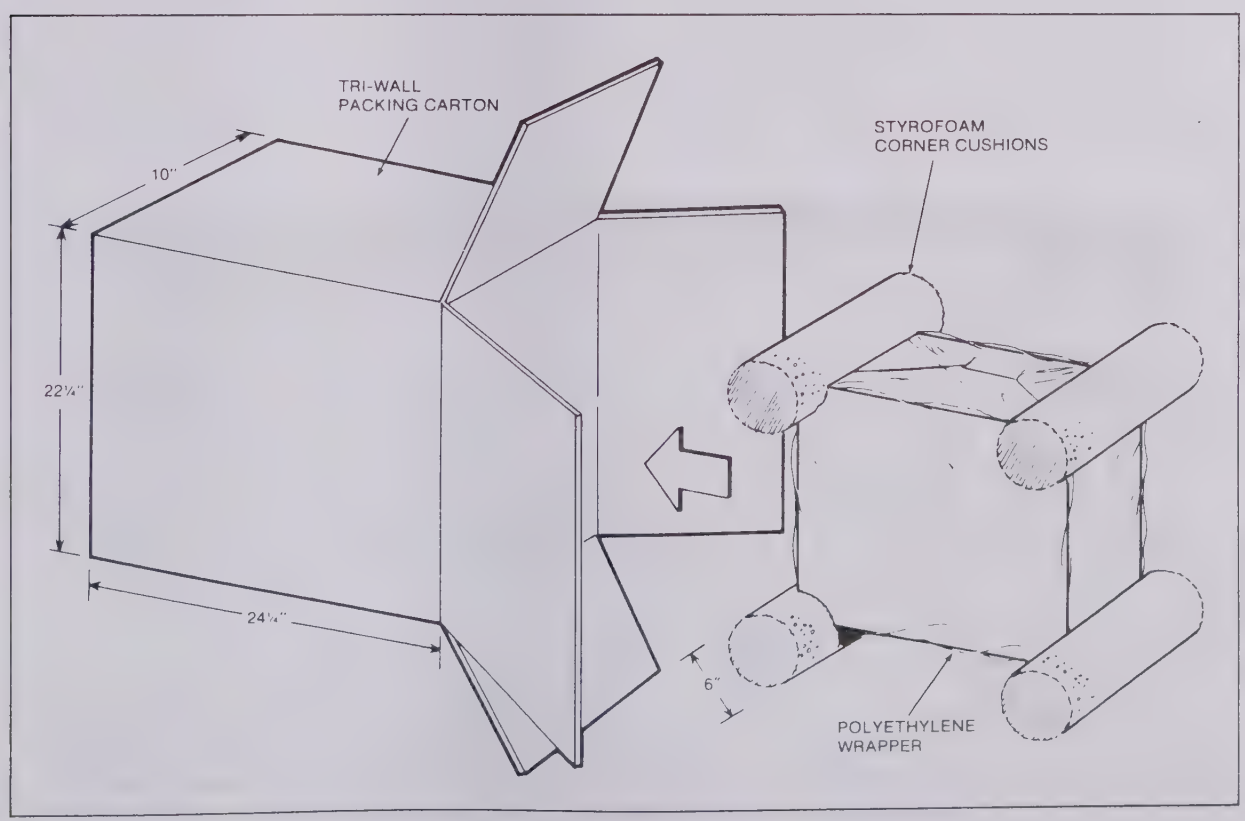


Figure 2-1 Packaging Diagram

b. Refer to the drawing in the accessory package for the proper orientation of the two mounting brackets. Make certain that the slotted holes are facing to the front, and mount the brackets with the 8-32 screws and lockwashers as shown in the drawing.

c. Mount the signal generator in the rack using standard rack mounting screws through the slotted holes in the angle brackets.

NOTE

Feet and bail may be removed from the bottom cover to clear adjacent rack mounted units.

2-6. **Power Requirements.** The signal generator has a tapped power transformer and a line voltage switch which permit operation of the instrument from 100, 120, 220, or 240 volt ±10%, 50 to 400 Hz, single phase AC power sources. Power consumption is approximately 55 volt amperes at 60 Hz.

CAUTION

Always make certain that the line voltage switch on the rear panel of the signal generator is set to the position most nearly corresponding to the voltage of the available AC power source, and that a fuse of the correct rating is installed in the fuse holder before connecting the signal generator to any AC power source.

2-7. **Cable Connections.** Cable connections required depend upon the selected operating mode of the signal generator. Connecting cables are not supplied with the equipment. Cable connections that may be required are as follows:

a. **Output.** The RF output of the signal generator is available at the front panel OUTPUT connector (type N). Output impedance is 50 ohms. For operation with load impedances other than 50 ohms refer to paragraph 2-25.

b. **FM Input.** If the signal generator is to be frequency modulated by an external signal, or if an external drive signal is to be used for frequency sweeping, connect the external signal source to the front panel FM EXT connector (type BNC). Input impedance is 600 ohms. A nominal 1 volt rms signal is required for fs deviation.

c. **AM Input.** If the signal generator is to be amplitude modulated by an external signal, connect the external signal source to the front panel AM EXT connector (type BNC). Input impedance is 600 ohms, and a nominal 1 volt rms signal is required for 30 percent AM.

d. **Modulating Signal Output.** An isolated output signal from the internal modulation oscillator is available at the front panel OUT connector (type BNC). Output impedance is 600 ohms, and the nominal amplitude of the signal is 1 volt rms for sine waves; 5 volts peak-to-peak into 10k ohms is available when the LINE Hz RAMP is selected.

e. **Counter Input.** If the frequency counter circuits of the signal generator are to be used for external frequency measurements, connect the external signal source to the front panel COUNTER EXT connector (type BNC). Input impedance is 1 megohm shunted by 90 pF. Maximum input signal amplitude is 20 Vrms.

f. **Demodulated AM Output.** An isolated, demodulated AM output signal is available at the rear panel DEMOD AM OUT connector (type BNC). At frequencies below 5 MHz, additional filtering of the carrier frequency will be required for most applications.

g. **Phase Lock Reference Input and Output** *(Model 103D only).* If the output frequency of the Model 103D signal generator is to be phase locked to an external reference frequency, connect the external reference signal source to the rear panel LOCK REFERENCE 1 MHZ IN/OUT connector and set the switch to EXT. An input level of 0.2 to 5 volts rms into 1000 ohms is required. If the output frequency of the signal generator is phase locked to the internal reference frequency, this internal phase lock reference signal is available at the same connector for synchronization of other equipment.

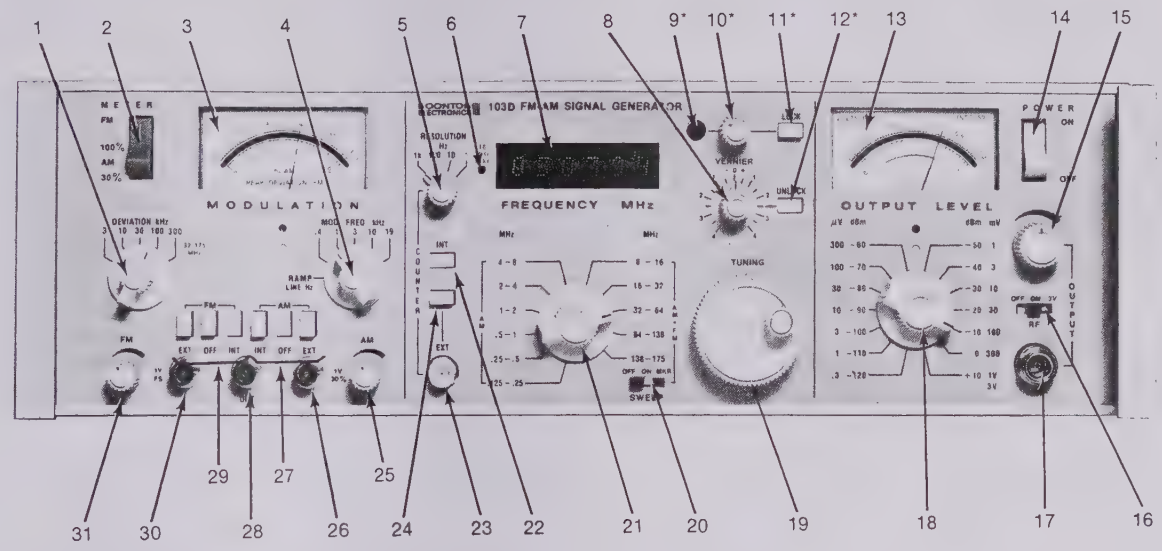
h. **Intensity Marker Output.** If an intensity marker is desired when using the frequency sweep (ramp) operating mode, connect the INTENSITY MARKER OUT connector on the rear panel to the Z axis of the oscilloscope in the test setup.

2.8 OPERATING CONTROLS, INDICATORS, AND CONNECTORS.

2-9. All controls, indicators, and connectors used during operation of the signal generator are shown in Figures 2-2 and 2-3. Table 2-1 lists their functions.

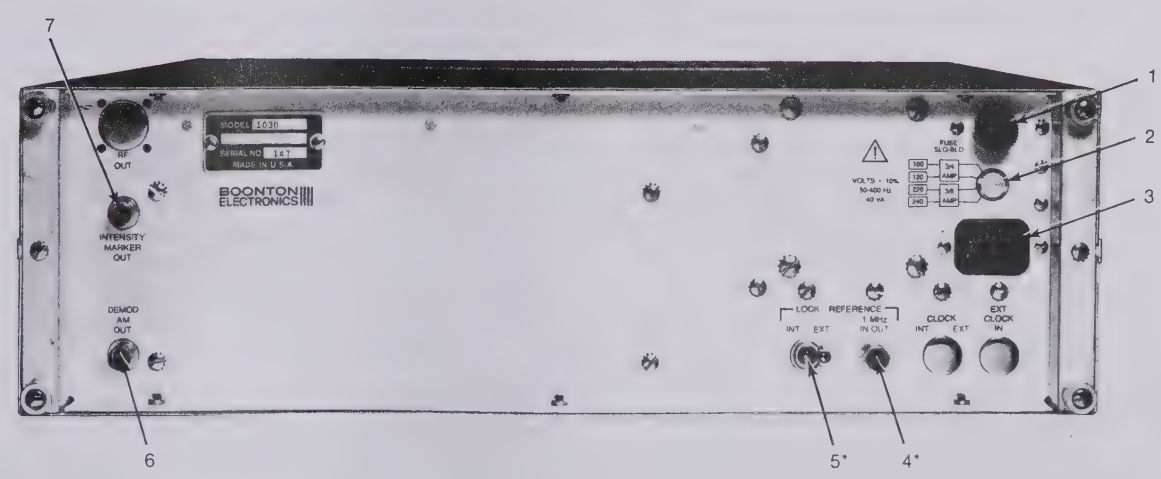
NOTE

In order to eliminate needless duplication, only the Model 103D signal generator is illustrated in Figures 2-2 and 2-3. Except for the items identified by an asterisk, *which are peculiar to the Model 103D,* all controls, indicators, and connectors shown also appear in similar positions on the Model 103C signal generator.



NOTE: ITEMS MARKED WITH ASTERISK ARE NOT INCLUDED IN MODEL 103C.

Figure 2-2 Signal Generator *(Model 103D)*, Front View



NOTE:
ASTERISKED ITEMS APPLY TO MODEL 103D ONLY.

NOTE: ITEMS MARKED WITH ASTERISK ARE NOT INCLUDED IN MODEL 103C.

Figure 2-3 Signal Generator *(Model 103D)*, Rear View

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

Control, Indicator, or Connector	Figure and Index No.	Function
NOTE Items marked by an asterisk apply to the Model 103D signal generator only.		
DEVIATION kHz switch	2-2, 1	Permits operator to select peak deviation limit for either external or internal FM. Actual FM deviation is adjustable from zero to selected limit by means of FM control. (300 position is usable only for output frequencies of 32 to 175 MHz.)
METER switch	2-2, 2	Permits operator to select MODULATION meter function. When switch is set to either AM position, MODULATION meter indicates percentage of AM; when switch is set to FM, meter indicates frequency deviation.
MODULATION meter	2-2, 3	Measures either percentage of AM or frequency deviation, as determined by setting of METER switch. Percentage of AM is indicated on lower scale for 30% AM switch setting, and on upper scale for 100% switch setting. Frequency deviation is indicated on lower scale for DEVIATION kHz switch settings of 3, 30, and 300, and on upper scale for switch settings of 10 and 100.
MOD FREQ kHz switch	2-2, 4	Permits operator to select any one of five sinusoidal internal modulating frequencies (0.4 kHz, 1 kHz, 3 kHz, 10 kHz, or 19 kHz) for either AM or FM, or line frequency ramp for frequency sweep operation.
RESOLUTION Hz switch	2-2, 5	Permits operator to select resolution of output frequency indicator display for precise measurement of signal generator output frequency; also performs same function for frequency measurements of external signals.
16 MHz MAX annunciator	2-2, 6	Lights when 1 Hz resolution is selected on band ranges 8 to 11 to alert operator to fact that this resolution can be used for frequencies up to 16 MHz only.
Output frequency indicator	2-2,7	Indicates frequency of signal generator RF output, or frequency of external signal applied to COUNTER EXT connector, by means of 6-digit LED display. Resolution is determined by setting of RESOLUTION Hz switch.
VERNIER control	2-2, 8	Permits operator to fine tune output frequency of signal generator.
*Phase lock annunciator	2-2, 9	When lighted steadily, indicates that signal generator output frequency is phase locked to internal or external reference frequency; when flashing, indicates that phase lock has been lost.
*Phase lock vernier	2-2, 10	Permits operator to fine tune output frequency of signal generator over limited range in phase lock mode of operation.
*LOCK switch	2-2, 11	When pressed, initiates phase lock mode of operation.
*UNLOCK switch	2-2, 12	Permits operator to open phase lock loop to restore unlocked mode of operation.

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (Cont.)

Control, Indicator, or Connector	Figure and Index No.	Function
OUTPUT LEVEL meter	2-2, 13	Indicates output level of signal generator in either volts or dBm into 50 ohms. Top scale is used for 10-series settings of OUTPUT LEVEL attenuator, middle scale is used for 3-series settings, and bottom scale is used for dBm indications. (0-3 scale is also used for high level mode output voltage indications.) dBm output level is sum of meter reading and dBm setting of OUTPUT LEVEL attenuator.
POWER switch	2-2, 14	Permits operator to control application of input AC power to signal generator.
OUTPUT control	2-2, 15	Permits operator to adjust output level to values between those obtainable using OUTPUT LEVEL attenuator, or to calibrate output level to values corresponding to OUTPUT LEVEL attenuator setting.
RF switch	2-2, 16	Permits operator to control RF output of signal generator. When set to OFF, RF output is reduced from OUTPUT connector; when set to ON, RF modulator is biased to normal output condition; when set to 3V, establishes high level output mode.
OUTPUT connector	2-2, 17	Provides means for connecting RF output signal of signal generator to load. Output impedance is 50 ohms.
OUTPUT LEVEL attenuator	2-2, 18	Permits operator to adjust RF output level in 10 dB steps.
TUNING control	2-2, 19	Permits operator to select output frequency within band selected by means of FREQUENCY MHz switch.
SWEEP switch	2-2, 20	Permits operator to select frequency sweep modes. When set to ON, initiates frequency sweep operation without marker; when set to MKR position, signal generator operates in frequency sweep mode, with VFO acting as marker oscillator (10.7 MHz and 98 MHz sweep ranges only); when set to OFF, discontinues frequency sweep operation.
FREQUENCY MHz switch	2-2, 21	Permits operator to select desired output frequency band.
COUNTER INT switch	2-2, 22	When pressed, internal counter circuits of signal generator measure and display frequency of RF output signal of signal generator.
COUNTER EXT connector	2-2, 23	Provides means for connecting external signal source to frequency counter circuits for frequency measurements.
COUNTER EXT switch	2-2, 24	When pressed, counter circuits of signal generator measure and display frequency of signal applied to COUNTER EXT connector.
AM control	2-2, 25	Permits operator to adjust percentage of AM.
AM EXT connector	2-2, 26	Provides means for connecting external modulating signal source for external AM functions.

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (Cont.)

Control, Indicator, or Connector	Figure and Index No.	Function
AM function switches	2-2, 27	Permits operator to select desired AM operating modes, as follows: When AM INT switch is pressed, AM operating mode using internal modulation oscillator is selected. When AM EXT switch is pressed, AM operating mode using external modulation signal is selected. When AM OFF switch is pressed, AM modulation circuits are inoperative.
OUT connector	2-2, 28	Provides isolated output signal (either sinusoidal or ramp, depending upon MOD FREQ kHz switch setting) from internal modulation oscillator for synchronization of external equipment at output impedance of 600 ohms and nominal signal level of 1 volt rms (sinewave). Delivers nominal 5 volts peak-to-peak into 10K ohms in RAMP position.
FM function switches	2-2, 29	Permits operator to select desired FM operating mode, as follows: When FM EXT switch is depressed, FM operating mode using external modulation signal is selected provided MOD FREQ KHz switch is not in the ramp position. When FM INT switch is depressed, FM operating mode using internal modulation oscillator is selected. When FM OFF switch is depressed, FM modulation circuits are inoperative.
FM EXT connector	2-2, 30	Provides means for connecting external modulation signal source for external FM functions of signal generator; also for frequency sweep functions using external drive.
FM control	2-2, 31	Permits operator to adjust deviation within peak deviation limit established by setting of DEVIATION kHz switch in FM operating modes.
Power fuse	2-3, 1	Protects signal generator power circuits against overloads.
Line voltage switch	2-3, 2	Connects power input circuits of signal generator for operation from 100, 120, 220, or 240 volt AC power source.
Power connector	2-3, 3	Provides means for connecting AC power source to signal generator.
*LOCK REFERENCE 1 MHz IN/OUT connector	2-3, 4	Provides means for connecting external 1 MHz phase lock reference signal source to phase lock circuits when LOCK REFERENCE INT/EXT switch is set to EXT position; when switch is set to INT position, provides means for connecting internal 1 MHz phase lock reference signal to external equipment.
*LOCK REFERENCE INT/EXT switch	2-3, 5	Permits operator to select either internal or external reference signal for phase lock operation.
DEMOD AM OUT connector	2-3, 6	Provides means for connecting demodulated AM signal output from signal generator to external equipment.
INTENSITY MARKER OUT connector	2-3, 7	Provides means for connecting 4 volt, 60 microsecond pulse to oscilloscope for use as intensity marker (10.7 MHz and 98 MHz sweep ranges only).

2-10. POWER APPLICATION.

2-11. The signal generator is designed for operation from a 100, 120, 220, or 240 volt, 50 to 400 Hz, single phase, AC power source. To apply power, proceed as follows:

a. Determine the line voltage at the AC power output receptacle, and set the line voltage switch on the rear panel of the signal generator to the position that most nearly corresponds to the available line voltage.

b. Check the value of the fuse in the rear panel fuseholder. For 100 or 120 volt operation, the fuse should be a 3/4 ampere, Slo-Blo type; for 220 or 240 volt operation, the fuse should be a 3/8 ampere, Slo-Blo type. If the rating of the fuse in the fuseholder is incorrect for the available line voltage, install a fuse of the proper rating in the fuseholder.

WARNING

The signal generator is designed to operate from a 3-terminal (one ground) AC power receptacle. To eliminate a potential shock hazard to operating personnel, use a 3-prong to 2-prong adapter if only a 2-terminal AC power receptacle is available. Connect the ground wire of the adapter to the power receptacle ground.

c. Connect the power cord supplied with the signal generator between the AC power receptacle and the power connector on the rear panel of the signal generator.

2-12. PRELIMINARY CHECK.

NOTE

The following checkout procedure is intended merely to ensure that all circuits of the signal generator are operating before the instrument is placed into use. If a detailed performance check against major performance specifications is desired, refer to paragraph 2-37.

2-13. Before using the signal generator, perform a preliminary check as follows:

a. Set the POWER switch to ON.

b. Rotate the OUTPUT control while observing the OUTPUT LEVEL meter. The OUTPUT LEVEL meter indication should be adjustable from full scale down to near zero by means of the OUTPUT control.

c. Set the FREQUENCY MHz switch to 64 – 138, and the TUNING control to any arbitrary setting. Press the COUNTER INT switch, and ascertain that the output frequency indicator provides a readout that falls within the selected frequency band. Rotate the VERNIER control and ascertain that the output frequency indicator display changes.

d. Starting at the 1k position, set the RESOLUTION Hz switch successively to each of its three remaining positions. With the switch set to 1k, the output frequency indicator display should include three digits to the right of the decimal point, and the number of digits to the right of the decimal point should increase by one for each switch position change, except for the 1 Hz position, at which the display should indicate 5 digits to the right of decimal point, and the LED alarm lamp should blink.

e. Press the FM INT switch, set the MOD FREQ kHz switch to 1, and set the METER switch to FM. Rotate the FM control and ascertain that the peak deviation, as indicated on the MODULATION meter, is adjustable to the peak value indicated by the DEVIATION kHz switch position.

f. Press the AM INT switch and set the METER switch to 100% AM. Rotate the AM control and ascertain that the modulation level, as indicated on the MODULATION meter, is adjustable to at least 100 percent.

g. Adjust the OUTPUT control to obtain a 0 dBm indication on the OUTPUT LEVEL meter. Using the TUNING control, tune the signal generator over one entire band, and ascertain that the indication on the OUTPUT LEVEL meter remains essentially constant over the entire band.

h. Set the FREQUENCY MHz switch successively to each of the remaining bands, and ascertain that, at each switch position, the readout of the output frequency indicator falls within the selected band and a relatively constant reading is indicated on the OUTPUT LEVEL meter.

i. Connect a jumper cable between the modulation OUT connector and the COUNTER EXT connector. Set the MOD FREQ kHz switch to 10, and the RESOLUTION Hz switch to 1. Press the AM INT and COUNTER EXT switches, and ascertain that the output frequency indicator display is approximately 10 kHz. Then, press the COUNTER INT switch and disconnect the jumper cable.

j. *On Model 103D only,* press the LOCK switch and ascertain that the phase lock indicator lights. Verify that slight rotation of the VERNIER control has no effect on the output frequency indicator display. Verify that the

phase lock vernier permits slight adjustment of the output frequency indication without loss of phase lock (phase lock indicator remains lighted).

2-14. OPERATING PROCEDURES.

2-15. General. Because of the flexibility of the signal generator, a variety of operating modes is available. Regardless of the operating mode selected, however, normal signal generator operation can be divided into four distinct steps: output frequency selection, modulation mode selection, adjustment of modulation levels, and adjustment of the output level. Procedures for these steps are covered in paragraphs 2-16 through 2-19. Procedures for specialized functions (frequency sweeping, frequency counter operations and phase lock operation) are covered in paragraphs 2-20 through 2-22.

2-16. Output Frequency Selection. To turn on the signal generator and select a particular output frequency, proceed as follows:

a. Set the POWER switch to ON.

b. Set the RESOLUTION Hz switch to 1k and the VERNIER control to 0.

c. Set the FREQUENCY MHz switch to the position that covers the desired output frequency, and adjust the TUNING control until the output frequency indicator displays the desired output frequency. Use the VERNIER control for fine adjustment of the output frequency.

d. If a greater resolution of the output frequency indicator display is required, set the RESOLUTION Hz switch to 100, 10, or 1, as applicable, and adjust the output frequency precisely to the desired value using the VERNIER control.

NOTE

Operation of the RESOLUTION Hz switch from 1k to successively lower settings effectively shifts the output frequency indicator display one digit to the left, adding one additional decimal digit, for each switch position change.

2-17. Modulation Mode Selection. After adjusting the output frequency, select the modulation mode using the AM and/or FM function switches, as applicable. The various possible modulation modes, together with the appropriate switch actuation, are as follows:

Modulation Mode	Function Switches Actuated
CW	AM OFF, FM OFF
External AM	AM EXT, FM OFF
External FM	FM EXT, AM OFF
External AM, external FM	AM EXT, FM EXT
Internal AM	AM INT, FM OFF
Internal AM, external FM	AM INT, FM EXT
Internal FM	FM INT, AM OFF
Internal FM, external AM	FM INT, AM EXT
Internal FM, internal AM	FM INT, AM INT

2-18. Adjustment of Modulation Levels. After selecting the desired modulation mode, adjust the modulation levels in accordance with the following procedures, as applicable:

a. **AM.** Adjust the percentage of AM as follows:

1. If the internal AM mode has been selected, select the desired modulation frequency using the MOD FREQ kHz switch.

2. If the external AM mode has been selected, ascertain that the external signal source is connected to the AM EXT connector, that the frequency (5 kHz maximum on band 1, 10 kHz maximum on bands 2 and 3, 20 kHz maximum on bands 4 through 11) of the external signal source has been adjusted to the desired value, and that the external AM signal level has been adjusted to a value adequate for the desired modulation level (1 volt rms for 30% AM).

3. Set the METER switch to 100% AM.

4. Using the AM control, adjust the percentage of modulation, as indicated on the MODULATION meter, to the desired value. For low modulation levels, set the METER switch to 30% when the indication on the upper scale of the MODULATION meter drops below 30%.

NOTE

When the METER switch is set to 100% AM, read the upper scale of the MODULATION meter; when the switch is set to 30% AM, read the lower scale.

b. **FM.** Adjust FM deviation as follows:

1. If the internal FM mode has been selected, select the desired modulation frequency using the MOD FREQ kHz switch.

2. If the external FM mode has been selected, set the MOD FREQ kHz switch to any of the sinewave positions. Ascertain that the external signal source is connected to the FM EXT connector, that the frequency (200 kHz maximum)

of the external signal source has been adjusted to the desired value, and that the external FM signal level has been adjusted to a value adequate for the desired deviation (1 volt rms for fs).

3. Select the desired peak deviation limit, using the DEVIATION kHz switch.

4. Set the METER switch to FM.

5. Using the FM control, adjust the deviation, as indicated on the MODULATION meter, to the desired value.

NOTE

Read the upper scale of the MODULATION meter when the DEVIATION kHz switch is set to 10 or 100. read the lower scale for DEVIATION kHz switch settings of 3, 30, or 300.

2-19. Adjustment of Output Level. Adjust the output level of the signal generator as follows:

a. Set the RF switch to ON for the normal output mode, or to 3 volts for the high output mode.

b. The normal output level, in dBm, is the algebraic sum of the dBm value selected by means of the OUTPUT LEVEL attenuator and the dB indication on the lowest scale of the OUTPUT LEVEL meter. For example, to obtain an output level of -32 dBm, set the OUTPUT LEVEL attenuator to -30 dBm, and adjust the OUTPUT control to obtain a -2 dB indication on the OUTPUT LEVEL meter.

NOTE

All output levels in dBm are calibrated for a load impedance of 50 ohms. The indications in dBm are not valid for other load impedances. Refer to paragraph 2-26 if the signal generator is to be used with load impedances other than 50 ohms.

c. Normal output voltage levels are indicated directly on the upper scale (for 10-series OUTPUT LEVEL attenuator settings) or the middle scale (for 3-series settings) of the OUTPUT LEVEL meter, using multipliers appropriate for the selected OUTPUT LEVEL attenuator setting. For calibrated output voltage levels corresponding to the OUTPUT LEVEL attenuator step values, set the OUTPUT LEVEL attenuator to the desired position, and adjust the OUTPUT control as required to obtain a 1.0 indication on the upper scale (10-series attenuator settings) or a 3.0 indication on the middle scale (3-series attenuator settings) on the OUTPUT LEVEL meter. For output voltage levels between the step values of the OUTPUT LEVEL attenuator, set the attenuator to the output voltage position immediately above the desired output voltage level, and adjust the OUTPUT control as required to obtain the desired output voltage level indication on the appropriate scale of the OUTPUT LEVEL meter. For example, to obtain an output voltage level of 5 mV, set the OUTPUT LEVEL attenuator to 10 mV, and adjust the OUTPUT control as required to obtain an indication of 0.5 on the top scale of the OUTPUT LEVEL meter.

NOTE

Output voltage indications are not affected by load impedances, but are correct only for 50 ohm loads.

d. When the high level mode has been selected, the output level is indicated directly on the 0 to 3 range of the OUTPUT LEVEL meter with the OUTPUT LEVEL attenuator set to its maximum clockwise setting. Adjust the OUTPUT control as required to obtain the desired output level indication in volts on the OUTPUT LEVEL meter.

NOTE

If the RF switch is set to OFF, very little RF output will be supplied to the load, although all signal generator operating indications (except rf output) are normal.

2-20. Frequency Sweep Operation. The signal generator has the capability of frequency sweeping over five of the most commonly used IF ranges. For frequency sweep operation, proceed as follows:

a. Set the POWER switch to ON.

b. Set the FREQUENCY MHz switch to the appropriate band, in accordance with the following:

Sweep Center Frequency	Band	FS MODULATION Meter Sensitivity
0.262 MHz	1	30 kHz
0.455 MHz	2	30 kHz
1.2 MHz	4	100 kHz
10.7 MHz	7	1 MHz
98 MHz	10	10 MHz

c. Set the SWEEP switch to ON.

d. Using the VERNIER control, adjust the center frequency to the desired value, as indicated on the output frequency indicator. Set the RESOLUTION Hz switch to the position appropriate for the desired resolution.

e. If an internal drive signal is to be used, set the MOD FREQ kHz switch to LINE Hz RAMP and depress the FM INT switch. If an external drive signal is to be used, connect the external drive signal source to the FM EXT connector, and depress the FM EXT switch.

f. Set the DEVIATION kHz switch to 300, and the METER switch to FM.

g. Using the FM control, adjust the sweep width to the desired value, as indicated on the MODULATION meter. (Full scale MODULATION meter sensitivities are listed in step b above.) Reduced amounts of deviation may be obtained by lower settings of the DEVIATION kHz SWITCH, each step providing a 10 dB reduction as in normal FM operation.

h. An intensity marker is available for use at the frequencies and deviations listed in Table 2-2. (The intensity marker is *not* available at any other frequencies.) To use the intensity marker, proceed as follows:

1. Check that the SWEEP switch is set to ON.

2. Check that the FREQUENCY MHz switch is set to the appropriate band in accordance with Table 2-2.

3. Using the VERNIER control, adjust the center frequency to the desired value.

4. Set the MOD FREQ kHz switch to LINE Hz RAMP.

5. Set the DEVIATION kHz switch to the appropriate position in accordance with Table 2-2. Set the METER switch to FM. Using the FM control, adjust the sweep width to the desired value, as indicated on the MODULATION meter. Set the SWEEP switch to MKR.

6. Connect the front panel OUT connector to the X and Y axes of an oscilloscope. Adjust the oscilloscope X axis controls as required to obtain a display of exactly one ramp.

7. Disconnect the ramp signal from the Y axis of the oscilloscope, and connect the signal to be observed to the oscilloscope Y axis.

8. Connect the rear panel INTENSITY MARKER OUT connector to the Z axis of the oscilloscope. A bright marker will appear on the oscilloscope trace at a position corresponding to the setting of the TUNING control and the frequency indicated on the output frequency indicator.

NOTE

The intensity marker should be used on the interior 80% of the sweep; however, it may be used on the initial and final 10% with degraded accuracy. Any additional markers that may appear in the initial and final 10% of the sweep under certain conditions should not be confused with the primary intensity marker in the interior 80% of the sweep. Accuracy is not degraded by such secondary markers.

TABLE 2-2. INTENSITY MARKER SPECIFICATIONS

Usable Marker Frequencies			Marker Uncertainty*	
Band	f_0	Deviation – Set Full Scale	Typical	Maximum
7	10.7 MHz	±300 kHz	<±0.5%	<±1%
7	10.7 MHz	±1 MHz	<±0.5%	<±1%
10	98 MHz	±10 MHz	<±0.25%	<±0.5%

*Percentage of sweep width from true position indicated on output frequency display

i. Adjust the output level of the signal generator in accordance with paragraph 2-19. The output sweep signal is available at the front panel OUTPUT connector.

2-21. **Frequency Counter Operation.** To use the external frequency counter capability of the signal generator, proceed as follows:

a. Set the POWER switch to ON.

b. Connect the external signal whose frequency is to be measured to the COUNTER EXT connector.

NOTE

The external signal frequency must be within the range of 5 Hz to 175 MHz, and the signal amplitude must not exceed 20 volts rms.

c. Depress the COUNTER EXT switch.

d. Set the RESOLUTION Hz switch to 1k, and read the frequency of the external signal directly on the output frequency indicator. If greater frequency resolution is desired, set the RESOLUTION Hz switch to 100, 10, or 1, as applicable.

NOTE

Use the 1 position of the RESOLUTION Hz switch for frequencies up to 16 MHz only.

2-22. Phase Lock Operation. *(Model 103D only).* To phase lock the output frequency of the signal generator to a 1 MHz reference signal, proceed as follows:

a. Set the rear panel LOCK REFERENCE INT/EXT switch to INT if the internal 1 MHz reference signal is to be used, or to EXT if an external 1 MHz lock reference signal is to be used. If an external lock reference signal is to be used, connect the external 1 MHz reference signal source to the rear panel LOCK REFERENCE 1 MHz IN/OUT connector.

NOTE

If the internal lock reference signal is selected, the 1 MHz internal lock reference signal is available at the LOCK REFERENCE 1 MHz IN/OUT connector for synchronizing other equipment.

b. Set the POWER switch to ON.

c. Select the desired output frequency in accordance with paragraph 2-16.

d. Press the LOCK switch. The phase lock indicator will light, indicating that phase lock has been achieved. Use the phase lock vernier for slight adjustments of the output frequency, if required.

e. If phase lock should be lost (as when making frequency changes), the phase lock indicator flashes. Depress the UNLOCK switch, adjust the output frequency to the desired value, and then depress the LOCK switch.

f. Select the desired modulation mode and adjust modulation and output levels in accordance with paragraphs 2-17 through 2-19.

2-23. APPLICATION NOTES.

2-24. General. Paragraphs 2-25 through 2-36 present typical application data for the signal generator. The signal generator is an extremely versatile instrument with many possible test applications, including circuit characterization, transmitter simulation, local oscillator substitution, and receiver measurements. Use of the signal generator is, therefore, in no way restricted to the applications covered in the following paragraphs; the application data is included merely to cover a few typical or specialized applications.

2-25. Impedance Matching. The output circuits of the signal generator are designed for operation into unbalanced, 50 ohm loads; therefore, the signal generator can be used to drive most loads directly. The output circuit design, however, does not preclude use with balanced loads, or with loads having impedances other than 50 ohms. When a matching network is employed, an appropriate correction factor must be applied to the readings of the OUTPUT LEVEL meter.

NOTE

The OUTPUT LEVEL meter will indicate the correct output level at the OUTPUT connector when an impedance matching network is used. The actual signal level at the load, however, may be greater or smaller than the indicated level, according to the nature of the network. Proper correction factors can be calculated, provided that circuit parameters are accurately known. In the event that the characteristics of the network are unknown, measurements should be made between input and output under loaded conditions, with a sensitive RF millivoltmeter, such as the Boonton Electronics Model 92B.

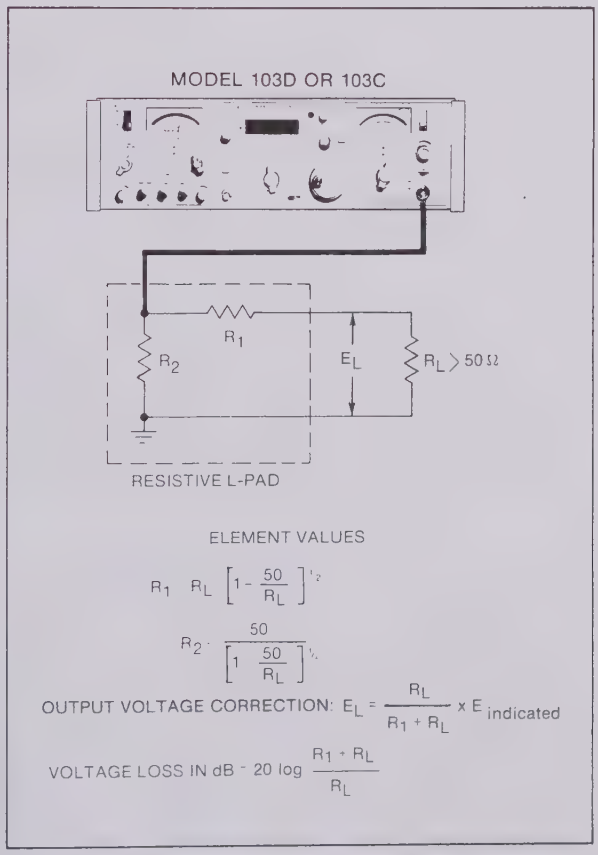

MODEL 103D OR 103C
R1
R2
EL
RL > 50 Ω
RESISTIVE L-PAD
ELEMENT VALUES
R1 RL [1 - 50/RL]^1/2
R2 50 / [1 50/RL]^1/2
OUTPUT VOLTAGE CORRECTION: EL = RL/(R1 + RL) x E indicated
VOLTAGE LOSS IN dB = 20 log (R1 + RL)/RL

Figure 2-4 Impedance Matching Network for Output Load Impedance Higher Than 50 Ohms

2-26. Consider the case where an output load impedance, higher than 50 ohms, is required. A network similar to that shown in Figure 2-4 can be used.

2-27. For example, if the output load (and desired source impedance) is 75 ohms: R_1 = 43.3 ohms, R_2 = 86.6 ohms, and a correction factor of 0.634 or 3.96 dB must be applied to the indication on the OUTPUT LEVEL meter. A different correction factor must be applied to determine the power delivered to the load because the impedance has been changed. Power loss (in dB) = $20 \log_{10} (R_1 + R_L)/R_L + 10 \log_{10} R_L/50$, or the delivered power can simply be calculated from: $P = E_L^2/R_L$. In this example, power loss in dB = 3.96 dB + 1.76 dB = 5.72 dB. If the OUTPUT LEVEL meter indication is -10 dBm, the power in the load is -10 dBm -5.72 dBm = -15.72 dBm.

2-28. In cases where a source impedance of less than 50 ohms is required to drive a low impedance load, a minimum loss matching pad of the configuration shown in Figure 2-5 is recommended. The formulas for calculation of the values of the matching pad are included as part of Figure 2-5.

2-29. Several standard tests for measuring receiver sensitivity (as defined by EIA Std RS-204 – Minimum Standards for Land-Mobile Communication FM or PM Receivers) define the source voltage as that developed at the generator output under open circuit conditions where the generator source impedance is 50 ohms. In Figure 2-6, this is the voltage measured across terminals A and B when the load is disconnected.

2-30. The Model 103C and Model 103D signal generators, however, are calibrated to read the voltage appearing at terminals A and B with a matched 50 ohm load connected. To facilitate this measurement, a matched 6 dB pad of the form shown in Figure 2-7 should be used. With this network connected between the signal generator and the receiver, the OUTPUT LEVEL meter of the signal generator correctly indicates the open circuit voltage required for this test.

2-31. For connection to receivers with balanced input terminals, a balun should be used to provide a balanced output voltage from the signal generator. For example, assume that it is desired to match the signal generator to a 300 ohm balanced input. First, the 50 ohm source impedance of the signal generator can be converted to a 75 ohm source in a manner described in paragraph 2-27. Next, the 75 ohm unbalanced load output can be connected to a 300 ohm balanced output by use of a 4:1 balun transformer as shown in Figure 2-8. The entire network can then be represented by Figure 2-9. A correction factor for the output voltage must be applied. The 75 ohm section drops the output voltage approximately 4 dB below that indicated by the signal generator OUTPUT LEVEL meter. The balun, conversely, increases the voltage by 6 dB, assuming it to be lossless. The overall result is a load voltage approximately 2 dB higher than that indicated on the OUTPUT LEVEL meter.

2-32. Alternate configurations for balun construction are shown in Figures 2-10 and 2-11. The configuration shown in Figure 2-10 will exhibit a relatively wideband response, while the configuration shown in Figure 2-11 will have a fairly narrow range because of the use of a resonant line section.

2-33. IF Response. The wide bandwidth required of many IF amplifiers is often attained through use of stagger-tuned, or overcoupled, double-tuned circuits. Alignment of such

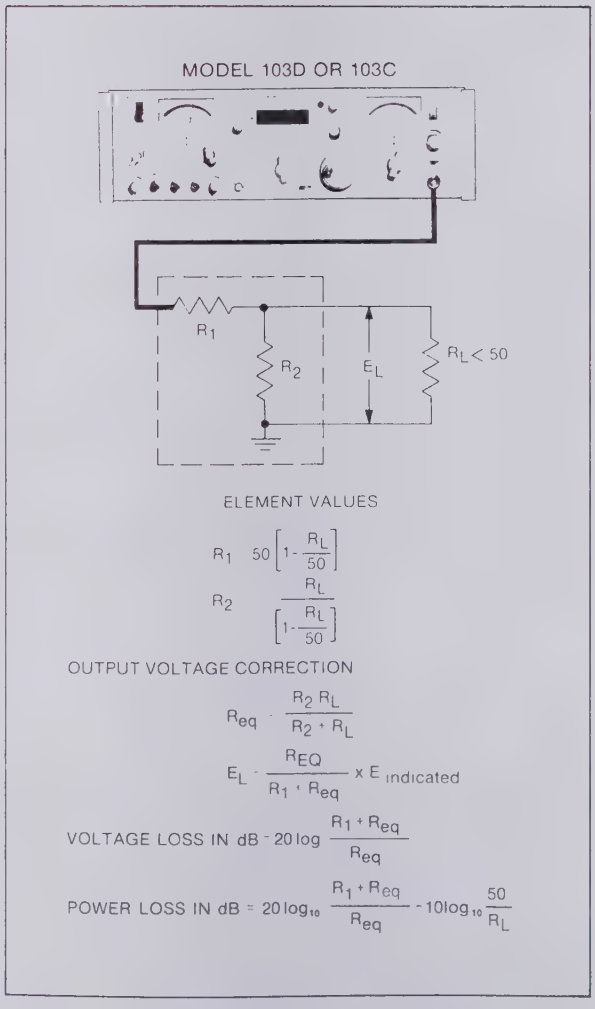

MODEL 103D OR 103C
R1
R2
EL
RL< 50
ELEMENT VALUES
R1 50 [1 - RL/50]
R2 RL / [1 - RL/50]
OUTPUT VOLTAGE CORRECTION
Req = R2 RL / (R2 + RL)
EL = REQ / (R1 + Req) x E indicated
VOLTAGE LOSS IN dB = 20 log (R1 + Req)/Req
POWER LOSS IN dB = 20 log10 (R1 + Req)/Req - 10 log10 50/RL

Figure 2-5 Impedance Matching Network for Output Load Impedance Lower Than 50 Ohms

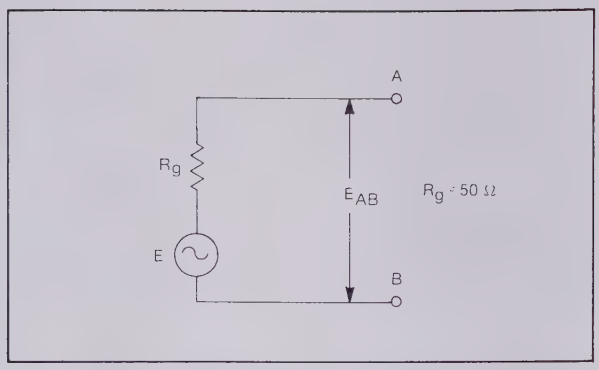


Figure 2-6 Generator Open Circuit Source Voltage

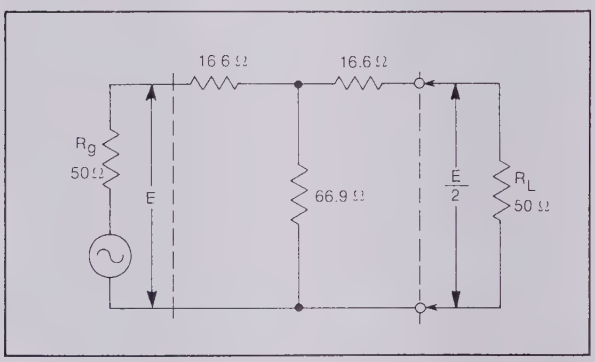


Figure 2-7 Matched 6 dB Pad

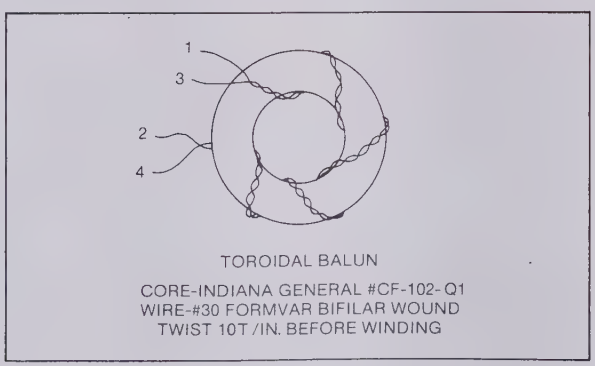


Figure 2-8 Toroidal Balun Construction Details

circuits, or checking of their response characteristics is facilitated through use of the frequency sweep function of the signal generator. A typical test arrangement is shown in Figure 2-12. Either an internal 50-60 Hz line synchronized ramp or an external drive signal (applied through the FM EXT connector) may be used. Modulation frequencies between 20 Hz and 100 Hz are recommended when using external drive. Operating procedures for the signal generator in the frequency sweep mode are provided in paragraph 2-20. Because the horizontal deflection circuits of the oscilloscope are driven by the modulating signal from the OUT connector of the signal generator, a linear frequency display along the horizontal axis of the oscilloscope is produced. The response curve may be marked in terms of frequency in order to measure bandwidth and indicate important frequency points. This can be accomplished through use of the built-in marker capability of the signal generator.

2-34. Phase Locking *(Model 103C).* In applications where extreme frequency stability is required, the Model 103C signal generator can be phase locked to an external frequency standard. Figure 2-13 shows the equipment arrangement for phase-locked operation. To achieve a lock, the output frequency of the signal generator is tuned to the frequency of the external reference source. When a lock has been achieved, it will be noted that the frequency VERNIER can be tuned for a portion of its range on either side of the locked frequency without changing the output frequency of the signal generator.

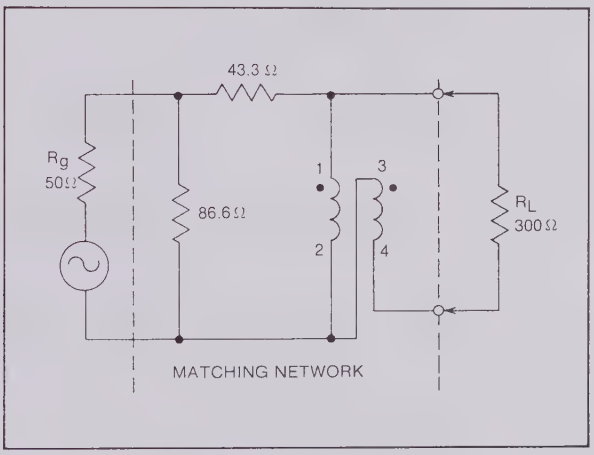


Figure 2-9 300 Ohm Balanced Matching Network

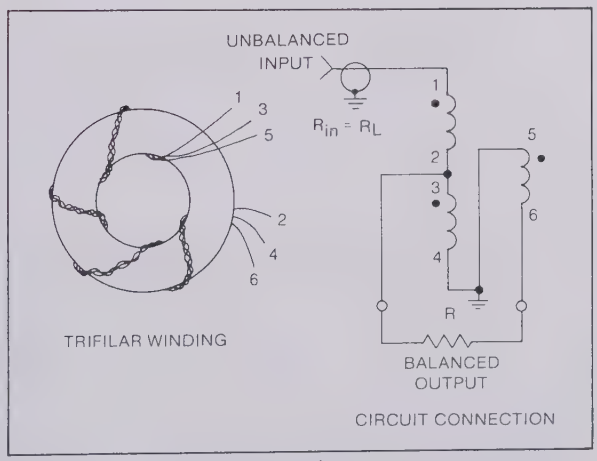


Figure 2-10 Wideband Response 1:1 Toroidal Balun

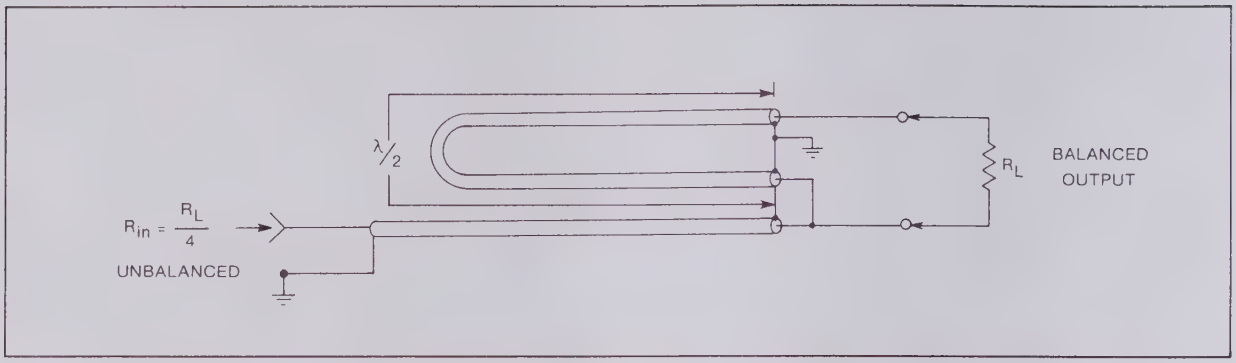


Figure 2-11 Narrowband Response 4:1 Coaxial Balun

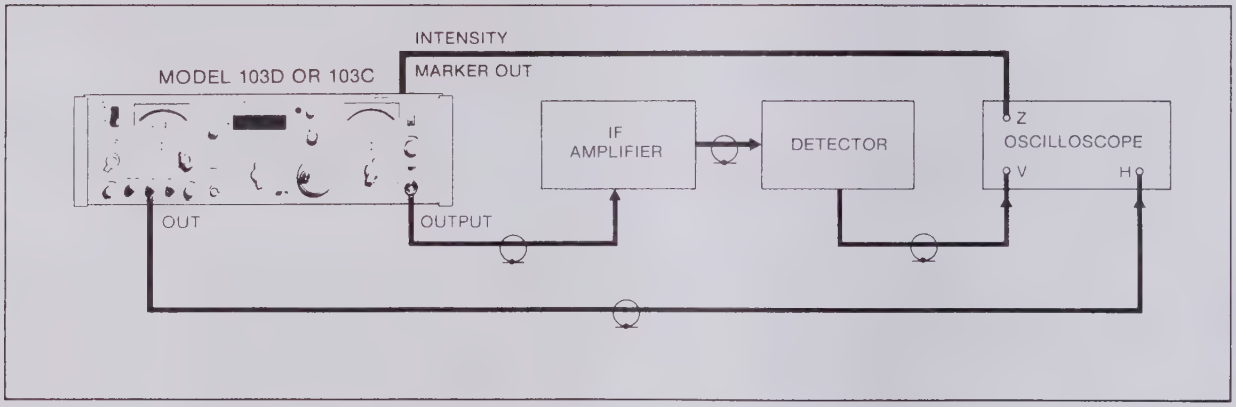


Figure 2-12 IF Response Measurement, Typical Equipment Connection

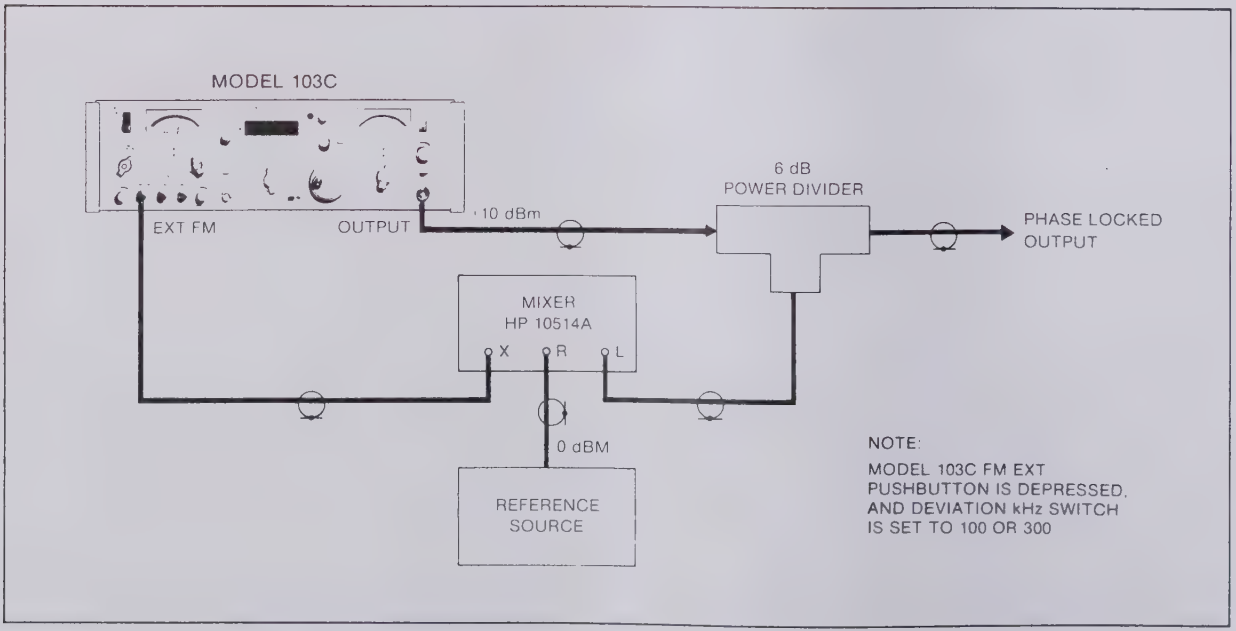


Figure 2-13 Phase Locking of Model 103C, Typical Equipment Connection

NOTE

The Model 103D signal generator has an internal phase lock capability. Refer to paragraph 2-22 for phase lock operating procedures for this model.

2-35. Non Harmonic Outputs. Multiplication techniques are not used in the signal generator. A heterohyning technique is used on the 138-175 MHz band and mixing products of more than 30 dB below the fundamental may be observed.

2-36. Visual Frequency Response Checks. Automatically leveled output and the direct-reading output frequency display are two features of the signal generator which make it extremely useful for quick visual checks of the frequency response characteristics of filters, amplifiers, and similar equipment. Figure 2-14 shows a typical equipment arrangement for such an application. Because the output of the signal generator is automatically leveled, tuning the instrument changes only one test parameter, the output frequency. To perform a quick visual check of response characteristics, the signal generator is tuned slowly over the frequency range of interest, while the signal level at the output of the device under test is monitored. At points where the output signal level deviates from normal, or at points where the output signal level reaches predetermined limits, the corresponding frequency can be read directly on the output frequency indicator of the signal generator.

NOTE

If the operating frequency of the item to be tested falls within the frequency sweep range of the signal generator, the same test function can be performed more conveniently using the frequency sweep and marker capabilities of the signal generator.

2-37. MINIMUM PERFORMANCE CHECKS.

2-38. Test Equipment Required. Table 2-3 lists all test equipment required to perform minimum performance checks of the signal generator.

TABLE 2-3. TEST EQUIPMENT LIST

Nomenclature	Model No.
AC Voltmeter	Boonton Electronics 93 AD
Amplifier	Hewlett-Packard 465A
Audio Oscillator	Hewlett-Packard 200CD
Attenuator, 6 dB	Microlab AB-06B
Attenuator, 100 dB	
Crystal Source, 100 MHz	
Detector, Crystal	Hewlett-Packard 8471A
Directional Coupler	Anzac CH-132
Distortion Analyzer	Hewlett-Packard 333A
Double Balanced Mixer	Hewlett-Packard 10514A
Filter, 15 kHz Low Pass	Boonton Electronics
Frequency Counter	Hewlett-Packard 5300B/5303B/5311B (opt. 001)
Frequency Meter	Hewlett-Packard 5210A
Microwattmeter	Boonton Electronics 42B
Modulation Meter	Boonton Electronics 82AD
Oscilloscope	Tektronix 5103N/5A20N/5B10N
Power Divider	Microlab DA-3FB
Signal Generator, FM-AM	Boonton Electronics 103D
Spectrum Analyzer	Hewlett-Packard 140T/8552B/8554B
Strip Chart Recorder	Rustrak Model A
Termination, 50 Ohm	Boonton Electronics 91-15A
Vector Voltmeter	Hewlett-Packard 8405A
T Adapter	Hewlett-Packard 11536A

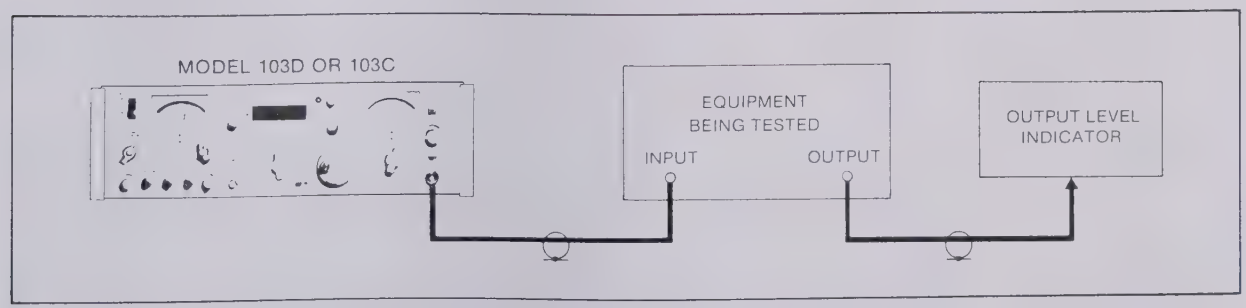


Figure 2-14 Frequency Response Checks, Typical Equipment Connection

2-39. Frequency Accuracy Check. To check the accuracy of the signal generator output frequency indicator, proceed as follows:

a. Set the signal generator POWER switch to ON, and allow the signal generator to warm up at room temperature for 1 hour.

b. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
RESOLUTION Hz switch	10
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	100.00000 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. Connect a frequency counter to the OUTPUT connector of the signal generator, and measure the signal generator output frequency. *The indication on the frequency counter should be between 99.99990 MHz and 100.0001 MHz.*

2-40. Frequency Range Check. Check the tuning range of the signal generator as follows:

a. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
RESOLUTION Hz switch	1k
FREQUENCY MHz switch	125-0.25
TUNING control	Fully counterclockwise
SWEEP switch	OFF
VERNIER control	0
RF switch	ON
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

b. Observe the display on the output frequency indicator. *The output frequency indication should be 0.125 MHz, or lower.*

c. Set the FREQUENCY MHz switch to 64-138, then to 138-175, and observe the display on the output frequency indicator for each switch setting. *The output frequency indications should be 64.000 MHz or less, and 138.000 MHz or less, respectively.*

d. Set the TUNING control to the fully clockwise position. Set the FREQUENCY MHz switch successively to .125-.25, 64-138, and 138-175, and observe the display on the output frequency indicator for each switch setting. *The output frequency indications should be 0.270 MHz or higher, and 138.000 MHz or higher, and 175.000 MHz or higher, respectively.*

2-41. Vernier Tuning Range Check. To check the tuning range of the VERNIER control, proceed as follows:

a. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
RESOLUTION Hz switch	1k
SWEEP switch	OFF
VERNIER control	Fully counterclockwise
FREQUENCY MHz switch	64-138
TUNING control	100.000 MHz indication on output frequency indicator
RF switch	ON

b. Set the VERNIER control to the fully clockwise position and observe the display on the output frequency indicator. *The output frequency indication should be between 100.017 MHz and 100.033 MHz.*

2-42. Frequency Stability Check. To check the frequency stability of the signal generator, proceed as follows:

NOTE

Ambient temperature must be maintained constant within ±1°C, and line voltage must be maintained constant within ±1 volt throughout this test. The signal generator should have been turned off for a period of 4 hours prior to this test.

a. Connect the signal generator and test equipment as shown in Figure 2-15.

b. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	100.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. Adjust the controls on the frequency counter and the recorder as required for 10 kHz full scale sensitivity on the strip chart.

d. Record continuously for 2 hours and 10 minutes. Note the peak-to-peak excursions on the strip chart recording during the final 10 minutes of the test. *The peak-to-peak excursions should not exceed 1.0 kHz. Verify that the plot during the first 2 hours is smooth and free of rapid frequency fluctuations.*

2-43. Output Level Accuracy Check. To check the accuracy of the signal generator output level, proceed as follows:

a. Connect a 50 ohm power detector of a calibrated microwattmeter to the OUTPUT connector of the signal generator.

b. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
RESOLUTION Hz switch	1K
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	100.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. Check the output power indication on the microwattmeter. *The indicated power level should be between -1.0 dBm and +1.0 dBm.*

d. Adjust the OUTPUT control as required to obtain indications of +3 dBm, -2 dBm, -4 dBm, -6 dBm, -8 dBm, and -10 dBm on the OUTPUT LEVEL meter, and check

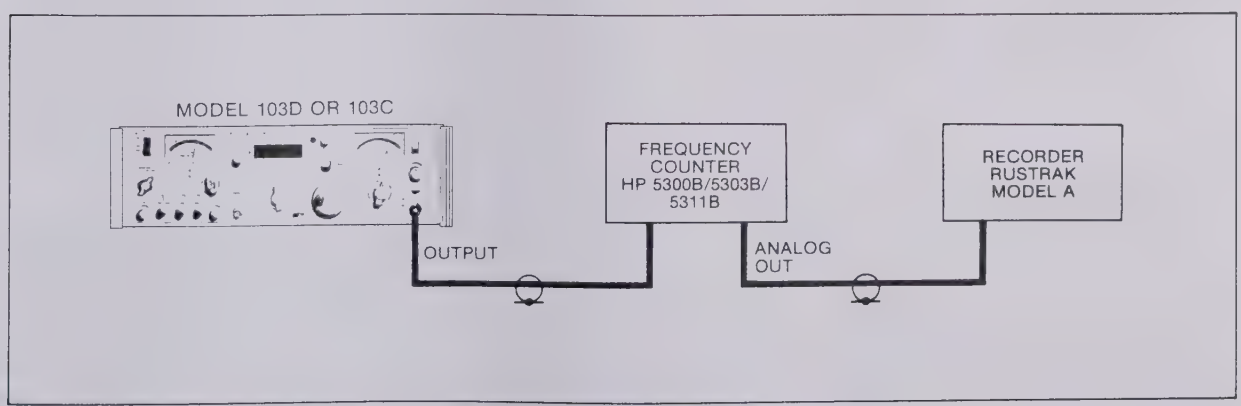


Figure 2-15 Frequency Stability Check, Test Setup

the microwattmeter indication for each of these output power settings. The microwattmeter indications should be as follows:

Output Setting	Measured Limits (dBm)
+3 dBm	+2.0 to +4.0
-2 dBm	-3.0 to -1.0
-4 dBm	-5.0 to -3.0
-6 dBm	-7.0 to -5.0
-8 dBm	-9.0 to -7.0
-10 dBm	-11.0 to -9.0

e. Repeat step c at the band limits on each range of the frequency MHz switch. *The indicated power level should be between -1.5 dBm and +1.5 dBm at the band 1 limits, and between -1.0 dBm and +1.0 dBm at all other band limits.*

f. Connect the signal generator and test equipment as shown in Figure 2-16.

g. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
RESOLUTION Hz switch	1k
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	100.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-100 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

h. With the spectrum analyzer operating in the linear display mode, adjust the spectrum analyzer controls as required to produce a display with the signal peak coincident with a reference graticule near the top of the screen.

i. Without using additional cables or adapters, connect the calibrated attenuator between the signal generator OUTPUT connector and the spectrum analyzer input.

j. Set the OUTPUT LEVEL attenuator to 0 dBm, and adjust the OUTPUT control as required to again set the signal peak on the spectrum analyzer display at the reference graticule.

k. Check the OUTPUT LEVEL indication on the OUTPUT LEVEL meter. *The indication should be within the limits specified by the formula (K - 100.0) ± 1.0 dBm, where K is the actual calibrated value of the 100 dB attenuator.*

2-44. **Output Leveling Check.** To check the operation of the automatic leveling circuits of the signal generator, proceed as follows:

a. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	138-175
TUNING control	Fully counterclockwise
RF switch	ON
OUTPUT LEVEL attenuator	+10 dBm
OUTPUT control	-1 dB indication on OUTPUT LEVEL meter

b. Connect the power detector of a microwattmeter to the OUTPUT connector of the signal generator, and note the microwattmeter indication on the +10 dBm full-scale range.

c. Using the TUNING control, tune the signal generator over the full frequency band, and record the maximum and minimum microwattmeter indications noted during this tuning process. Then, set the FREQUENCY MHz switch to each of its remaining positions in succession, and record the maximum and minimum microwattmeter indications noted when the TUNING control is rotated to tune the signal generator over each frequency band. *The difference between the maximum indication recorded for any range and the minimum indication recorded for any range should not exceed 1.0 dB.*

d. Set the signal generator OUTPUT LEVEL attenuator to 0 dBm, and adjust the OUTPUT control as required to obtain a -1 dBm indication on the microwattmeter (0 dBm full-scale range). Repeat step c for all positions of the FREQUENCY MHz switch. *The difference between the maximum indication recorded for any range and the minimum indication recorded for any range should not exceed 1.0 dB.*

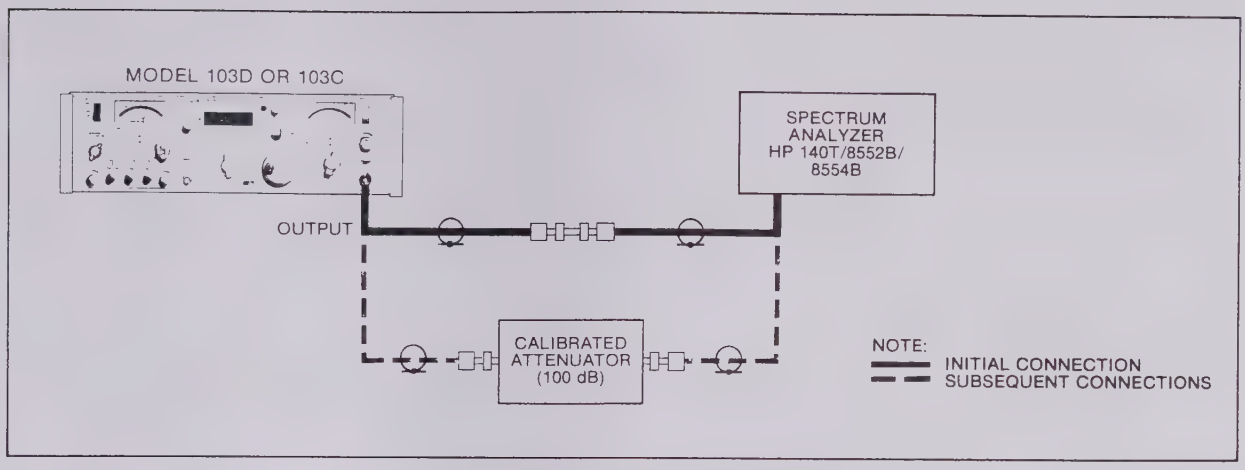


Figure 2-16 Output Level Accuracy Check, Test Setup

2-45. Output VSWR Check. To check the signal generator VSWR, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-17.

b. Set the controls of the *test* signal generator as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	8-16
TUNING control	10.0 MHz indication on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. Set the controls of the *reference* signal generator as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	8-16
TUNING control	10.3 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

d. Connect the spectrum analyzer to terminal A of the directional coupler, and connect the 50 ohm termination to terminal B. With the spectrum analyzer set for a 0.5 MHz/ division scan width, tune the spectrum analyzer as required to center the *reference* signal generator output signal on the display, and adjust the RF and IF attenuators of the spectrum analyzer as required to position the signal peak at the -30 dB graticule.

e. Interchange the spectrum analyzer and 50 ohm termination connections at the directional coupler. On the spectrum analyzer display, check the difference in dB between the new signal amplitude and the -30 dB graticule. *This difference should be not less than 18 dB.*

NOTE

This procedure actually measures return loss, which is related to VSWR. A return loss of 18 dB corresponds to a VSWR of 1.288:1.

f. Using the procedures of preceding steps d and e, measure the return loss at *test* signal generator output frequencies of 50 MHz, 100 MHz, and 175 MHz. Set the *reference* signal generator output frequency 0.3 MHz above that of the *test* signal generator in each case. *At each of the*

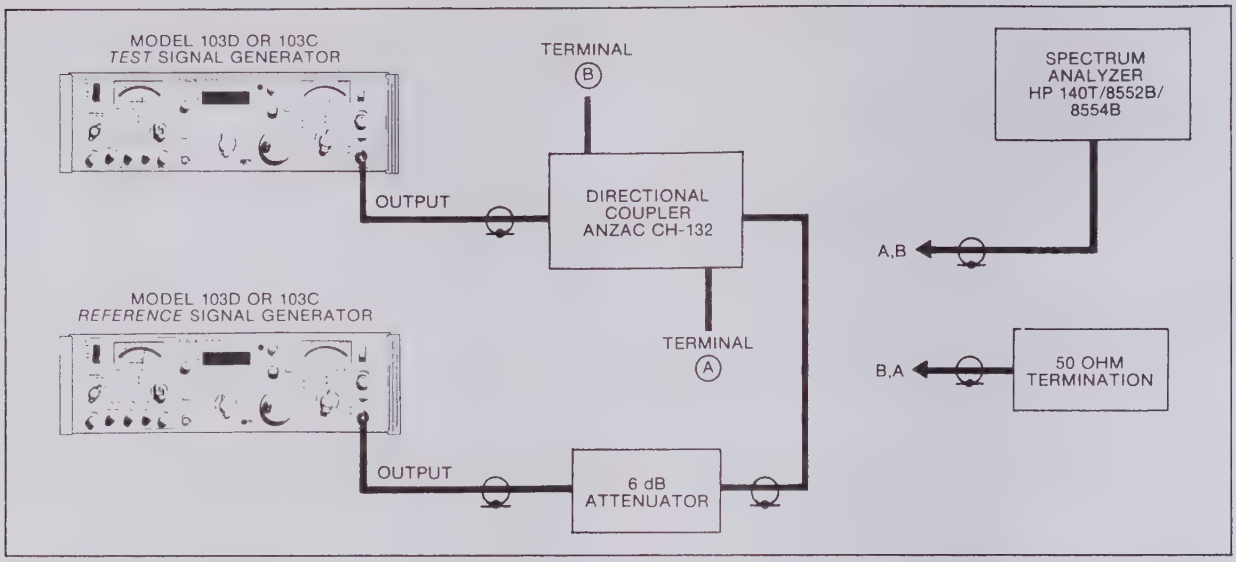


Figure 2-17 VSWR Check, Test Setup

test frequencies, the difference in dB between the new signal amplitude and the -30 dB graticule should be not less than 18 dB.

2-46. Harmonic and Spurious Output Check. To check harmonics and other spurious outputs of the signal generator, proceed as follows:

a. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
RESOLUTION Hz switch	1k
SWEEP switch	OFF
FREQUENCY MHz switch	.125-.25
TUNING control	0.125 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

b. Connect a spectrum analyzer to the signal generator OUTPUT connector.

c. Set the spectrum analyzer scan width to 200 kHz/division, and tune the spectrum analyzer as required to display the zero beat within 1 division of the left edge of the screen.

d. Using the TUNING control, tune the signal generator slowly across the entire frequency band, noting the maximum level of the harmonics on the spectrum analyzer display. *Harmonic amplitude should be at least 30 dB below the signal generator output signal amplitude.* Verify that spurious signals other than harmonics are at least 60 dB below the desired output on the spectrum analyzer display.

e. Repeat step d for each of bands 2 through 10 of the signal generator, using the spectrum analyzer scan widths specified below. *Harmonic amplitude on each band should be at least 30 dB below the signal generator output signal amplitude.* Non-harmonic outputs should be at least 60 dB down.

Frequency Band	Scan Width
2	500 kHz/division
3	500 kHz/division
4	1 MHz/division
5	2 MHz/division
6	5 MHz/division
7	10 MHz/division
8	20 MHz/division
9	50 MHz/division
10	100 MHz/division

f. Set the FREQUENCY MHz switch to 138-175. Set the spectrum analyzer scan width to 100 MHz/division. Using the TUNING control, tune the signal generator slowly across the entire band, and check the maximum amplitude of harmonics of the desired output, and the maximum amplitude of all other spurious signals. *Maximum harmonic amplitude should be at least 30 dB below the desired signal generator output signal amplitude; maximum spurious signal amplitude should also be at least 30 dB below the signal generator output signal amplitude.*

2-47. **Modulation Oscillator Output Level and Distortion Checks.** To check the output level and distortion of the internal modulation oscillators, proceed as follows:

a. Set the signal generator controls as follows:

Control	Setting
AM INT switch	Depressed
FM OFF switch	Depressed
AM control	Fully counterclockwise
MOD FREQ kHz switch	.4

b. Connect a distortion analyzer to the front panel modulation OUT connector of the signal generator.

c. Using the distortion analyzer in its voltmeter mode, measure the AC voltage at the OUT connector. *The distortion analyzer voltage indication should be 2.0 to 2.6 volts rms.*

d. Set the MOD FREQ kHz switch successively to 1, 3, 10, and 19, and measure the AC voltage at the OUT connector for each switch setting. *The distortion analyzer voltage indication should be 2.0 to 2.6 volts rms for each switch setting.*

e. Using the distortion analyzer in its distortion mode, measure the distortion of the signal at the OUT connector for each of positions .4, 1, 3, 10, and 19 of the MOD FREQ kHz switch. *The distortion indication on the distortion analyzer should not exceed 0.2% for any switch setting.*

2-48. **Modulation Oscillator Frequency Accuracy Check.** To check the frequency accuracy of the internal modulation oscillators, proceed as follows:

a. Set the signal generator controls as follows:

Control	Setting
AM INT switch	Depressed
FM OFF switch	Depressed
COUNTER EXT switch	Depressed
RESOLUTION Hz switch	1
AM control	Fully counterclockwise
MOD FREQ kHz switch	4

b. Connect the INT OSC output to the EXT COUNT input of the generator.

c. Check the indication on the output frequency indicator. *The frequency indication should be .000388 to .000412.*

d. Set the MOD FREQ kHz switch to 1. *The frequency indication on the output frequency indicator should be between .000970 and .001030.*

e. Set the MOD FREQ kHz switch to 3. *The frequency indication on the output frequency indicator should be between .002910 and .003090.*

f. Set the MOD FREQ kHz switch to 10. *The frequency indication on the output frequency indicator should be between .009700 and .010300.*

g. Set the MOD FREQ kHz switch to 19. *The frequency indication on the output frequency indicator should be between .018430 and .019570.*

2-49. **FM Sensitivity Check.** To check the FM sensitivity of the signal generator, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-18.

b. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM EXT switch	Depressed
COUNTER INT switch	Depressed
FM control	Fully clockwise
DEVIATION kHz switch	100
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	100.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. Set the modulation meter to the 100 kHz full-scale range in the FM mode. Set the modulation meter measurement bandwidth to 30 Hz to 15 kHz.

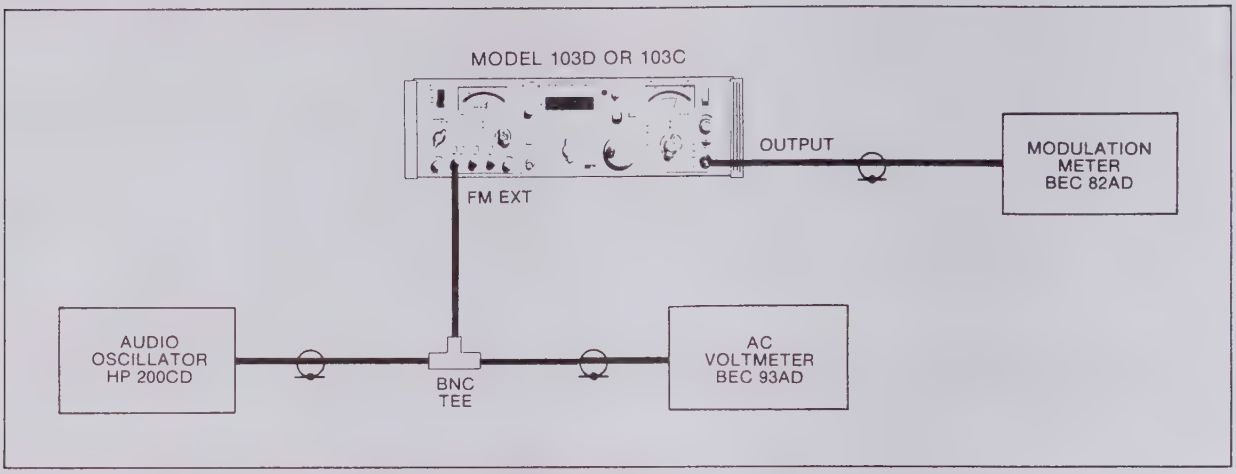


Figure 2-18 FM Sensitivity Check, Test Setup

d. Set the audio oscillator output frequency to 1 kHz, and adjust the audio oscillator output level to the point that produces a 100.0 kHz indication on the external modulation meter.

e. Check the AC voltage indication on the AC voltmeter. *The AC voltage should be in the range of 0.6-1.2 vrms.*

2-50. FM Deviation Accuracy Check. To check the signal generator deviation accuracy, proceed as follows:

a. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM INT switch	Depressed
DEVIATION kHz switch	100
COUNTER INT switch	Depressed
MOD FREQ kHz switch	1
METER switch	FM
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	65.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

b. Connect a modulation meter to the OUTPUT connector of the signal generator. Set the modulation meter to the 100 kHz full-scale range in the FM mode. Set the modulation meter measurement bandwidth to 30 Hz to 15 kHz.

c. Adjust the signal generator FM control to the point where the deviation indication on the MODULATION meter is exactly 100 kHz. *The deviation indication on the external modulation meter should be 93.0 kHz to 107.0 kHz.*

d. Using the TUNING control, tune the signal generator from 65 MHz to 135 MHz in 5 MHz increments. *At each output frequency, the deviation indication on the external modulation meter should be between 93.0 kHz and 107.0 kHz.*

2-51. FM Distortion Check. To check FM distortion, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-19.

b. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM INT switch	Depressed
COUNTER INT switch	Depressed
METER switch	FM
DEVIATION kHz switch	100
MOD FREQ kHz switch	1
FM control	100 kHz indication on MODULATION meter
SWEEP	OFF

FREQUENCY MHz switch	8-16
TUNING control	10.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. Set the external modulation meter to the 100 kHz full-scale range in the FM mode. Set the modulation meter filters to provide a 20 Hz to 15 kHz measurement bandwidth.

d. Using the distortion analyzer, measure the distortion. *Total harmonic distortion (THD) should not exceed 2.0%.*

e. Tune the signal generator successively to each of the output frequencies listed below, and check the distortion indication on the distortion analyzer for each of the listed output frequencies. *THD should not exceed the listed values.*

Output Frequency (MHz)	Maximum THD
12	2%
14	2%
16 (Band 7)	2%
16 (Band 8)	1%
32 (Band 9)	0.5%
64 (Band 10)	0.3%
100	0.3%

f. With the signal generator tuned to 100 MHz, adjust the FM control as required to produce a 75 kHz indication on the MODULATION meter. Using the distortion analyzer, measure the distortion. *THD should not exceed 0.2%.*

2-52. FM Bandwidth Check. To check the FM bandwidth of the signal generator, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-20.

b. Set the *test* signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM EXT switch	Depressed
COUNTER INT switch	Depressed
SWEEP switch	OFF
DEVIATION kHz switch	100
METER switch	FM
FREQUENCY MHz switch	64-138
TUNING control	100.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. Set the *reference* signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	108.0 MHz indication on output frequency indicator

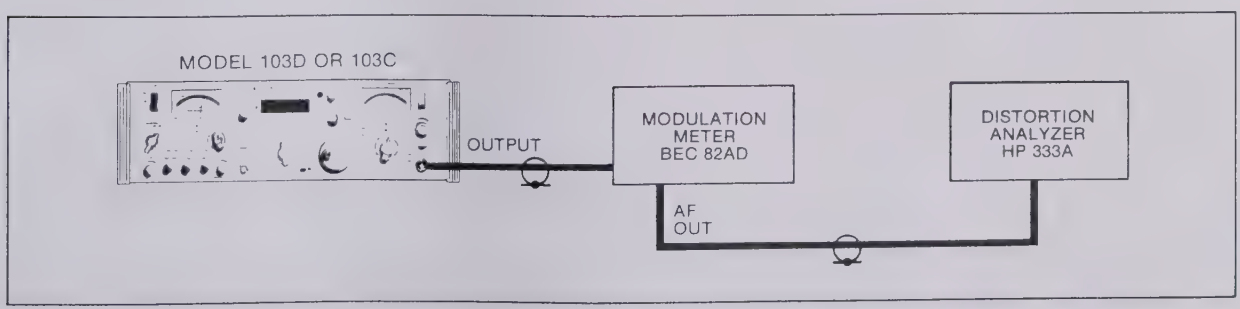


Figure 2-19 FM/AM Distortion Check, Test Setup

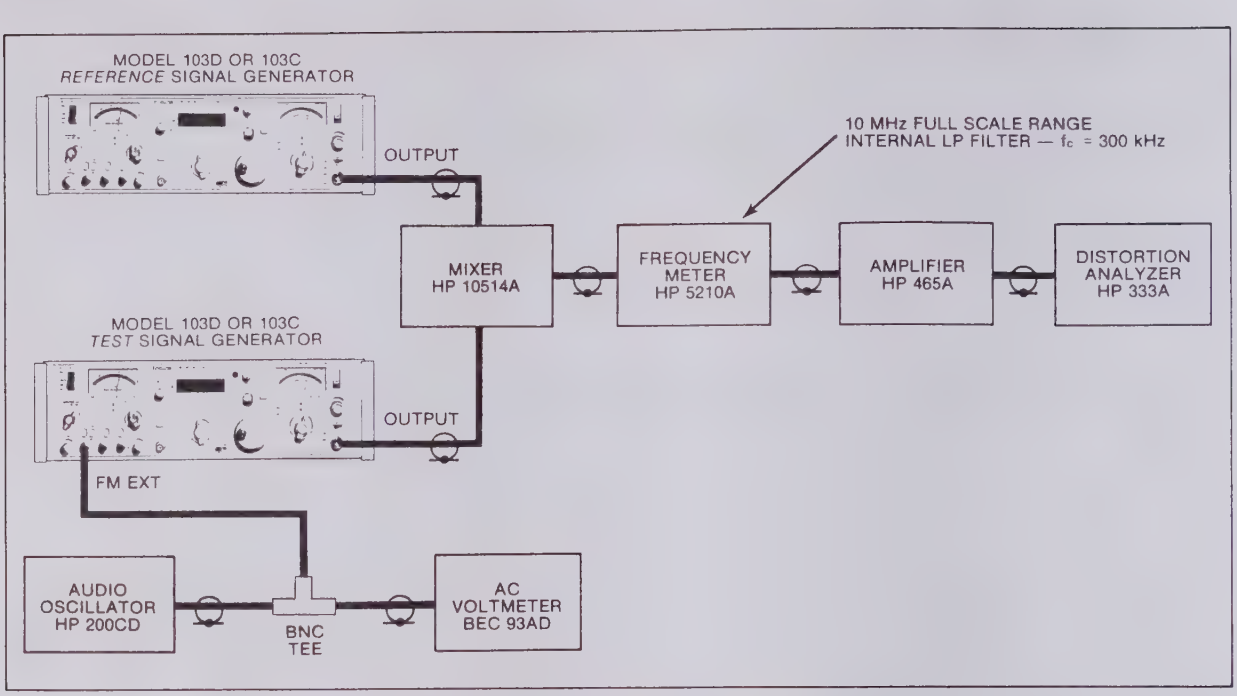


Figure 2-20 FM Bandwidth Check, Test Setup

RF switch	ON
OUTPUT LEVEL attenuator	+10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

d. Adjust the audio oscillator frequency to 1 kHz, and adjust the audio oscillator output level as required to obtain a 2.0 volt indication on the AC voltmeter.

e. Using the signal generator FM control, set the pointer of the MODULATION meter to 100.

f. With the distortion analyzer operating in the set level mode, adjust the distortion analyzer controls as required to produce a full scale indication on the distortion analyzer meter.

g. Adjust the audio oscillator output frequency to 200 kHz. Adjust the audio oscillator output level to the point where a full scale indication is again obtained on the distortion analyzer meter. Check the voltage indication on the AC voltmeter. *The AC voltage indication should be between 1.41 and 2.82 volts rms.*

2-53. Incidental AM with FM Check. To check the level of incidental AM with FM, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-21.

b. Set the signal generator controls as follows:

Control	Setting
AM INT switch	Depressed
FM OFF switch	Depressed
METER switch	30% AM
MOD FREQ kHz switch	1
AM control	10% indication on MODULATION meter
COUNTER INT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	100.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	+10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. With the distortion analyzer operating in the set level mode, adjust the distortion analyzer controls as required to obtain a 0 dB indication on the highest possible range.

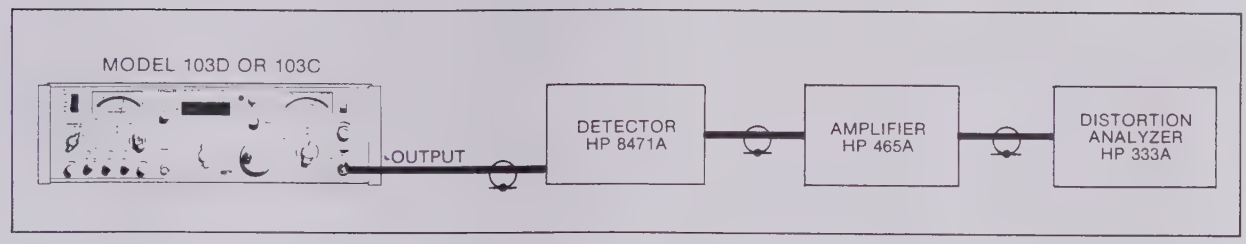


Figure 2-21 Incidental AM with FM Check, Test Setup

d. Depress the signal generator AM OFF and FM INT switches. Set the METER switch to FM and the DEVIATION kHz switch to 100. Using the FM control, adjust the pointer of the MODULATION meter to the full scale position.

e. Step down the distortion analyzer attenuators to measure the incidental AM, relative to the reference level. *Incidental AM should be at least 32 dB below the 0 dB reference level.*

2-54. AM Sensitivity Check. To check the AM sensitivity of the signal generator, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-22.

b. Set the signal generator controls as follows:

Control	Setting
AM EXT switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
AM control	Fully clockwise
SWEEP switch	OFF
FREQUENCY MHz switch	8-16
TUNING control	10.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. Set the external modulation meter to the 100% full scale range in the AM mode. Set the modulation meter filters to provide a 30 Hz to 15 kHz measurement bandwidth.

d. Set the audio oscillator output frequency to 1 kHz, and adjust the audio oscillator output level to the point required to produce a 30.0% indication on the external modulation meter. Check the indication on the AC voltmeter. *The AC voltage indication should not exceed 1.0 volt rms.*

2-55. AM Accuracy Check. To check AM accuracy, proceed as follows:

a. Set the signal generator controls as follows:

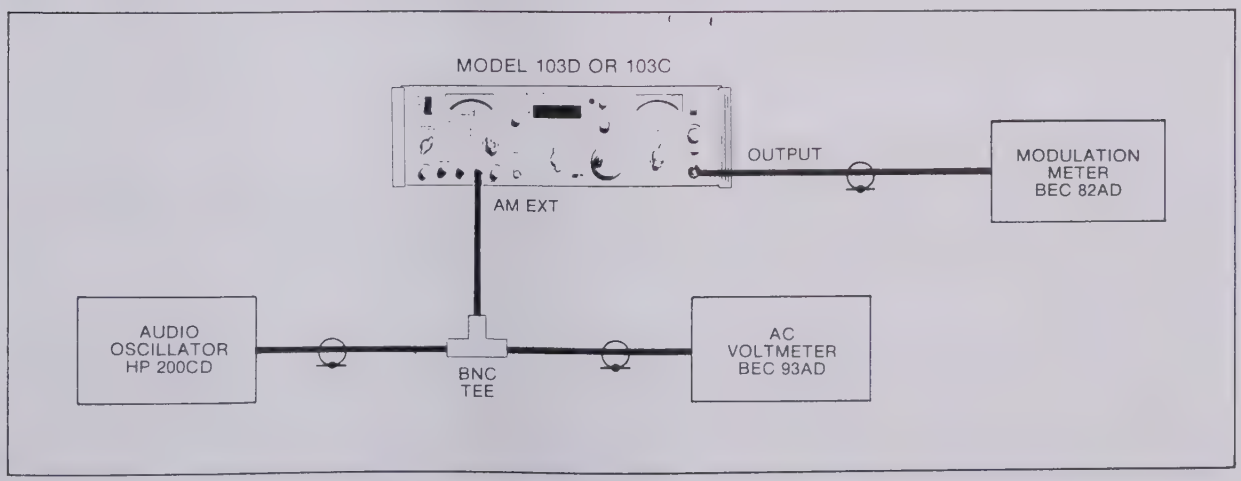


Figure 2-22 AM Sensitivity Check, Test Setup

Control	Setting
AM INT switch	Depressed
FM OFF switch	Depressed
METER switch	100% AM
MOD FREQ kHz switch	1
COUNTER INT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	100.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

b. Connect a modulation meter to the OUTPUT connector of the signal generator. Set the modulation meter to the 100% full-scale range in the AM mode. Set the modulation meter filters to provide a 30 Hz to 15 kHz measurement bandwidth.

c. Using the signal generator AM control, position the pointer of the signal generator MODULATION meter exactly at the 30% mark on the meter scale. Observe the percentage of AM indicated on the external modulation meter. *The external modulation meter indication should be between 26.9% and 33.1%.*

d. Using the signal generator AM control, position the pointer of the signal generator MODULATION meter exactly at the 50% mark on the meter scale. Observe the percentage of AM indicated on the external modulation meter. *The external modulation meter indication should be between 45.5% and 54.5%.*

e. Using the signal generator AM control, position the pointer of the signal generator MODULATION meter exactly at the 80% mark on the meter scale. Observe the percentage of AM indicated on the external modulation meter. *The external modulation meter indication should be between 73.4% and 86.6%.*

f. Repeat preceding step d at signal generator output frequencies of 10 MHz, 20 MHz, 40 MHz, 146 MHz, and 175 MHz. *The external modulation meter indication should be between 46.5% and 53.5% for each of the specified output frequencies below Band 10, and between 45.5% and 54.5% for frequencies in Bands 10 and 11.*

2-56. **AM Distortion Check.** To check AM distortion, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-19.

b. Set the signal generator controls as follows:

Control	Setting
AM INT switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
METER switch	100% AM
MOD FREQ kHz switch	1
AM control	30% indication on MODULATION meter
SWEEP switch	OFF
FREQUENCY MHz switch	8-16
TUNING control	10.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. Set the external modulation meter to the 100% full-scale range in the AM mode. Set the modulation meter filters to provide a 30 Hz to 15 kHz measurement bandwidth.

d. Using the distortion analyzer, measure the distortion. *THD should not exceed 1.0%.*

e. Measure the distortion at signal generator output frequencies of 16 MHz, 32 MHz, 64 MHz, 138 MHz, and 175 MHz. *THD should not exceed 1.0% at any of the specified output frequencies.*

f. Using the signal generator AM control, position the pointer of the signal generator MODULATION meter to the 80% mark on the meter scale. Using the distortion analyzer, measure the distortion at signal generator output frequencies of 10 MHz, 16 MHz, 32 MHz, 64 MHz, 138 MHz, and 175 MHz. *THD should not exceed 3.0% at any of the specified output frequencies.*

2-57. AM Range Ratio and Tracking Checks. Proceed as follows:

a. Set the signal generator controls as follows:

Control	Setting
METER switch	30% AM
AM INT switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
MOD FREQ kHz switch	1
AM control	30% indication on MODULATION meter
SWEEP switch	OFF
FREQUENCY MHz switch	32-64
TUNING control	50.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

b. Connect a modulation meter to the OUTPUT connector of the signal generator. Set the modulation meter to the 100% full-scale range in the AM mode, and set the modulation meter filters to provide a 30 Hz to 15 kHz measurement bandwidth.

c. Observe the indication on the external modulation meter. *The indicated percentage AM should be between 26.9% and 33.1%.*

d. Set the signal generator METER switch to 100% AM. Note the indication on the signal generator MODULATION meter. *The MODULATION meter indication should be between 29.0% and 31.0%.*

e. Adjust the signal generator OUTPUT control to the point where a -10 dB indication is obtained on the OUTPUT LEVEL meter. Observe the indication on the external modulation meter. *The indicated percentage AM should be between 26.9% and 33.1%.*

2-58. AM Bandwidth Check. To check the AM bandwidth, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-23.

b. Set the signal generator controls as follows:

Control	Setting
AM EXT switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	100.0 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

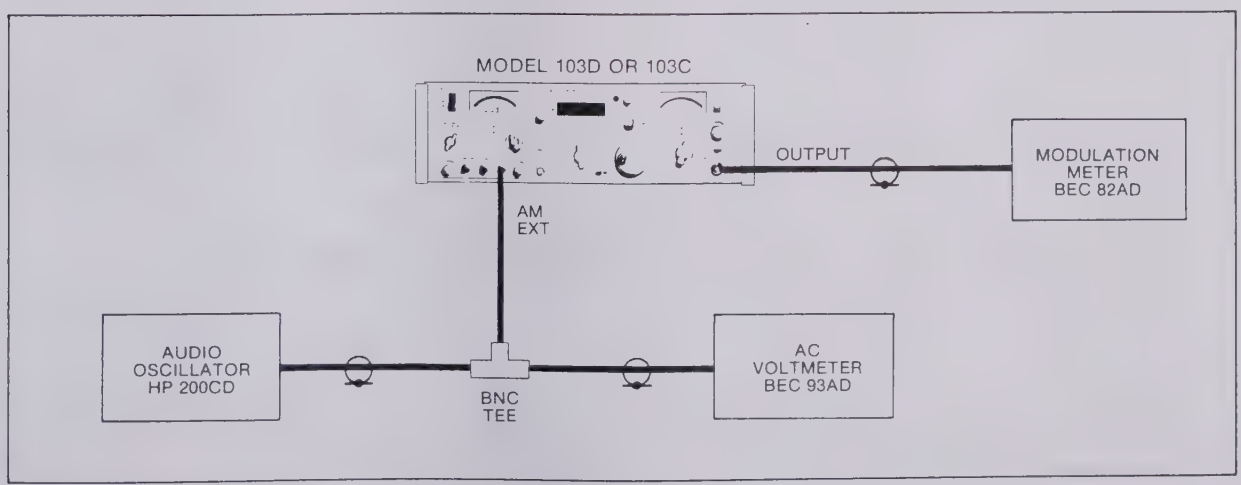


Figure 2-23 AM Bandwidth Check, Test Setup

c. Set the external modulation meter to the 100% full-scale range in the AM mode, and set the modulation meter filters to provide a 30 Hz to 120 kHz measurement bandwidth.

d. Set the audio oscillator output frequency to 1 kHz, and adjust the audio oscillator output level to the point where a 2.00 volt rms indication is obtained on the AC voltmeter.

e. Adjust the signal generator AM control as required to produce a 50.0% AM indication on the external modulation meter.

f. Adjust the output frequency of the audio oscillator to 20 kHz, and adjust the output level to the point where a 50.0% AM indication is again obtained on the external modulation meter. Observe the AC voltmeter indication. *The AC voltmeter indication should be between 1.41 volts and 2.82 volts rms.*

2-59. **Incidental PM with AM Check.** To check incidental PM with AM, proceed as follows:

a. Remove the instrument top cover and the top cover of the RF housing section.

b. Connect the signal generator and test equipment as shown in Figure 2-24.

c. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	64-138 MHz
TUNING control	100 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter

d. Set the vector voltmeter frequency range control to 100 MHz, and the amplitude control to channel A. Adjust the phase zero control as required to obtain a zero phase indication on the voltmeter.

e. Adjust the signal generator OUTPUT control as required to produce a 2.3 dB increase in the amplitude of the signal generator output signal. Note the indication on the vector voltmeter.

f. Adjust the signal generator OUTPUT control as required to produce a signal generator output level that is -3.1 dB from the original level. Again note the indication on the vector voltmeter. *The peak excursion of the vector voltmeter should not exceed 11.5 degrees (0.2 radian).* This test simulates 30% AM modulation.

2-60. **Residual FM Check.** To check residual FM, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-25.

b. Set the signal generator controls as follows:

Control	Setting
METER switch	FM
AM OFF switch	Depressed
FM INT switch	Depressed
DEVIATION kHz switch	3
MOD FREQ kHz switch	1
FM control	1 kHz deviation indication on MODULATION meter
COUNTER INT switch	Depressed
SWEEP switch	OFF
RESOLUTION Hz switch	1k
FREQUENCY MHz switch	64-138
TUNING control	100.095 MHz indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	0 dBM
OUTPUT control	0 dB indication on OUTPUT LEVEL meter

c. With the distortion analyzer operating in the set level mode, adjust the distortion analyzer sensitivity controls as required to produce a 0 dB indication on the 30% range of the distortion analyzer meter. This establishes a 1 kHz deviation reference.

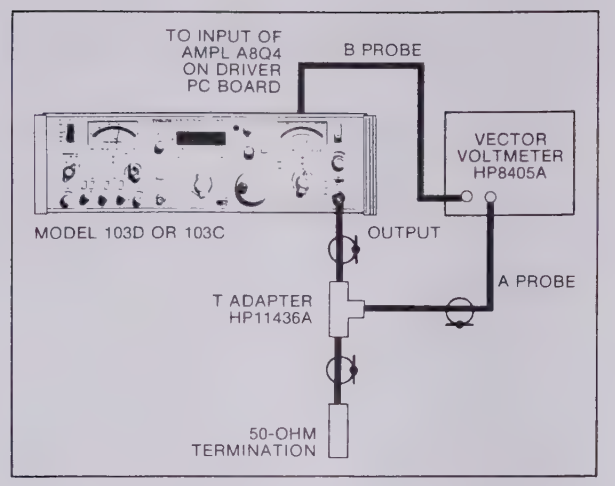


Figure 2-24 Incidental PM with AM Check, Test Setup

d. Press the signal generator FM OFF switch.

e. Turn the distortion analyzer step attenuator counterclockwise until the residual reading on the distortion analyzer meter moves upscale. Determine the level of the residual indication in dB relative to the 0 dB reference. *The residual indication should be at least 34 dB below the 0 dB reference (20 Hz).*

2-61. Sweep Tuning Range Check. To check the sweep tuning range, proceed as follows:

a. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
RESOLUTION Hz switch	1k
SWEEP switch	ON
FREQUENCY MHz switch	.125-.25

b. Rotate the VERNIER frequency control to produce an indicated output frequency of 0.262 MHz.

c. Note the position of the pointer relative to the panel markings. Limits: -2.5 to +2.5.

d. In a like manner determine the tuning points of the other sweep ranges.

Band Range	F_O	Limits
0.25-0.5 MHz	.455 MHz	-2.5 to +2.5
1-2 MHz	1.2 MHz	-2.5 to +2.5
8-16 MHz	10.7 MHz	-2.5 to +2.5
64-138 MHz	98 MHz	-2.5 to +2.5

2-62. Sweep Accuracy Check. To check sweep accuracy, proceed as follows:

a. Set the generator controls as follows:

METER switch	FM
FM INT switch	Depressed
AM OFF switch	Depressed
DEVIATION kHz switch	300
MOD FREQ kHz switch	0.4 kHz
FM LEVEL	30 indication on lower scale of meter
COUNTER INT switch	Depressed

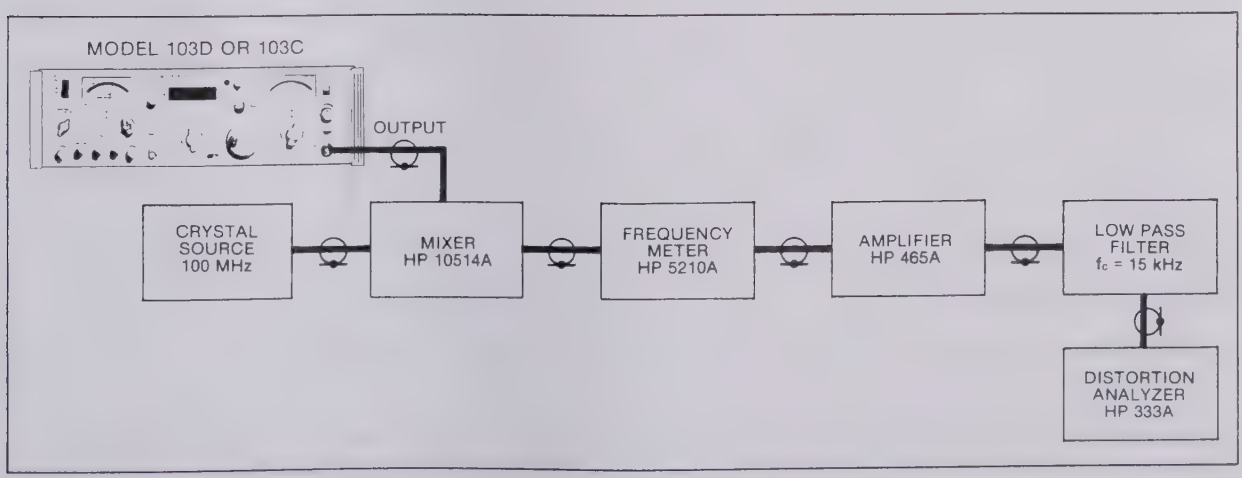


Figure 2-25 Residual FM Check, Test Setup

SWEEP switch	ON
FREQ RANGE	.125-.25 MHz
RF switch	ON
OUTPUT LEVEL	0 dBm indication on OUTPUT LEVEL meter

b. Connect the RF OUTPUT to the input of a spectrum analyzer (HP 140T/8552B/8554B).

c. Switch the FM to OFF and adjust the vernier control to obtain a .262 MHz indication on the frequency display.

d. Switch the FM to INT and adjust the spectrum analyzer to display the signal at a scan width of 10 kHz/div.

e. Verify that a peak to peak deviation of 6 divisions (60 kHz) is obtained. LIMITS: 5.4 to 6.6 divisions.

f. Switch the frequency range to .25 – .50 MHz and repeat steps d and e at a center frequency of .455 MHz.

g. Switch the frequency range to 1 – MHz with the FM switch at OFF, adjust the VERNIER control to obtain a frequency of 1.2 MHz.

h. Switch the FM to INT and adjust the FM level control for a reading of 100 on the upper scale of the generator modulation meter. Adjust the spectrum analyzer to display the signal at a scan width of 50 kHz/div.

i. Verify that a peak-to-peak deviation of 4 divisions (200 kHz) is obtained. LIMITS: 3.6 to 4.4 divisions.

j. Switch the frequency range to 8 -- 16 MHz with the FM switch at OFF, adjust the VERNIER control to obtain an output frequency of 10.7 MHz.

k. With the FM at INT, adjust the spectrum analyzer to display the signal at a scan width of 0.5 MHz/div.

l. Verify that a peak to peak deviation of 4 divisions (2 MHz) is obtained. LIMITS: 3.6 to 4.4 divisions.

m. Switch the frequency range to 64 – 138 MHz. With the FM switch OFF, adjust the VERNIER control to obtain an output frequency of 98 MHz.

n. With the FM at INT, adjust the spectrum analyzer to display the signal at a scan width of 5 v Hz/div.

o. Verify that a peak-to-peak deviation of 4 divisions (20 MHz) is obtained. LIMITS: 3.6 to 4.4 divisions.

2-63. **Frequency Counter Sensitivity Check.** To check the sensitivity of the frequency counter circuits, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-26.

b. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
RESOLUTION Hz switch	1k
COUNTER EXT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	.125-.25
RF switch	ON
OUTPUT LEVEL attenuator	-20 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter
TUNING control	.125 MHz indication on output frequency indicator

c. Using the TUNING control, tune the signal generator slowly across the band. *The output frequency indicator display should follow the output frequency without erratic indications.*

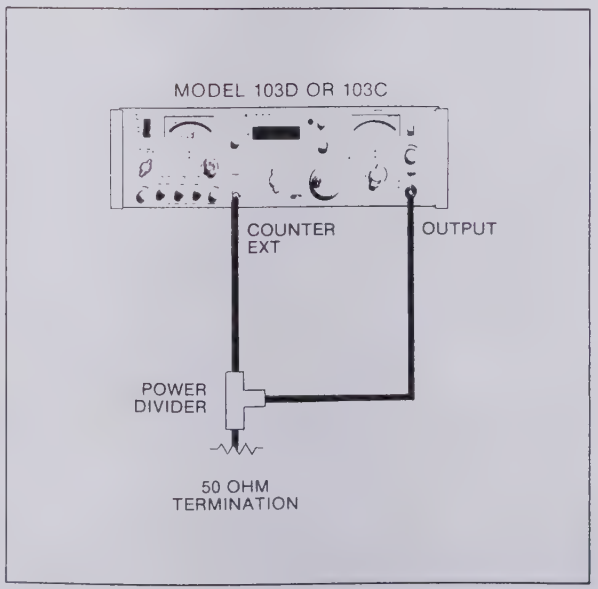


Figure 2-26 Frequency Counter Sensitivity Check, Test Setup

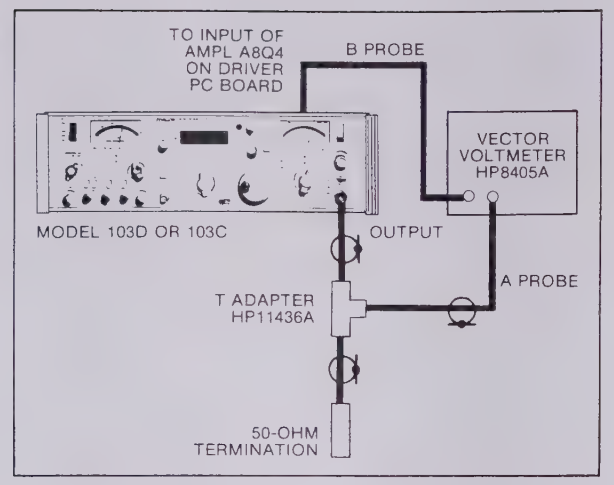


Figure 2-24 Incidental PM with AM Check, Test Setup

d. Press the signal generator FM OFF switch.

e. Turn the distortion analyzer step attenuator counterclockwise until the residual reading on the distortion analyzer meter moves upscale. Determine the level of the residual indication in dB relative to the 0 dB reference. *The residual indication should be at least 34 dB below the 0 dB reference (20 Hz).*

2-61. Sweep Tuning Range Check. To check the sweep tuning range, proceed as follows:

a. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
RESOLUTION Hz switch	1k
SWEEP switch	ON
FREQUENCY MHz switch	.125-.25

b. Rotate the VERNIER frequency control to produce an indicated output frequency of 0.262 MHz.

c. Note the position of the pointer relative to the panel markings. Limits: -2.5 to +2.5.

d. In a like manner determine the tuning points of the other sweep ranges.

Band Range	F_O	Limits
0.25-0.5 MHz	.455 MHz	-2.5 to +2.5
1-2 MHz	1.2 MHz	-2.5 to +2.5
8-16 MHz	10.7 MHz	-2.5 to +2.5
64-138 MHz	98 MHz	-2.5 to +2.5

2-62. Sweep Accuracy Check. To check sweep accuracy, proceed as follows:

a. Set the generator controls as follows:

METER switch	FM
FM INT switch	Depressed
AM OFF switch	Depressed
DEVIATION kHz switch	300
MOD FREQ kHz switch	0.4 kHz
FM LEVEL	30 indication on lower scale of meter
COUNTER INT switch	Depressed

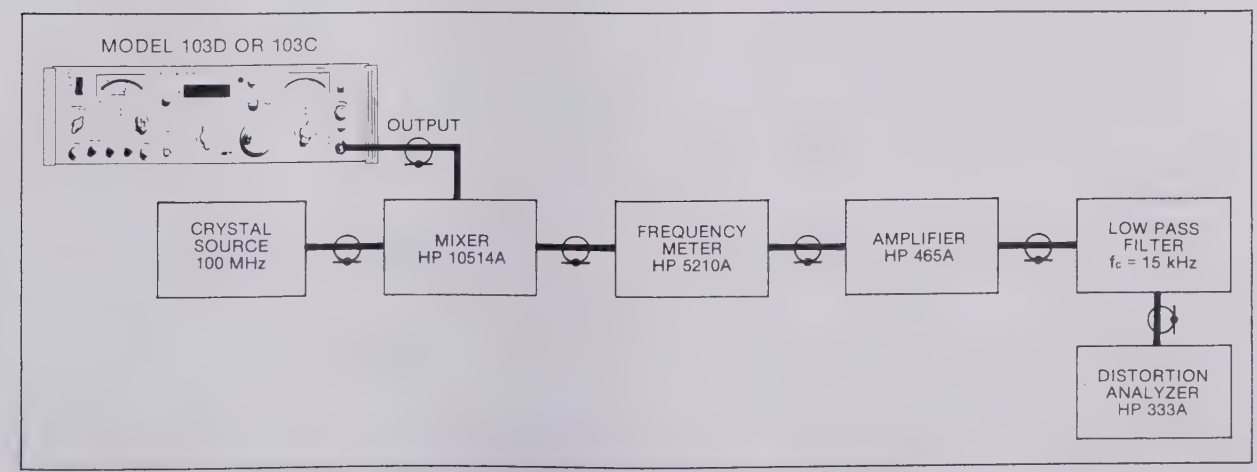


Figure 2-25 Residual FM Check, Test Setup

SWEEP switch	ON
FREQ RANGE	.125-.25 MHz
RF switch	ON
OUTPUT LEVEL	0 dBm indication on OUTPUT LEVEL meter

b. Connect the RF OUTPUT to the input of a spectrum analyzer (HP 140T/8552B/8554B).

c. Switch the FM to OFF and adjust the vernier control to obtain a .262 MHz indication on the frequency display.

d. Switch the FM to INT and adjust the spectrum analyzer to display the signal at a scan width of 10 kHz/div.

e. Verify that a peak to peak deviation of 6 divisions (60 kHz) is obtained. LIMITS: 5.4 to 6.6 divisions.

f. Switch the frequency range to .25 – .50 MHz and repeat steps d and e at a center frequency of .455 MHz.

g. Switch the frequency range to 1 – MHz with the FM switch at OFF, adjust the VERNIER control to obtain a frequency of 1.2 MHz.

h. Switch the FM to INT and adjust the FM level control for a reading of 100 on the upper scale of the generator modulation meter. Adjust the spectrum analyzer to display the signal at a scan width of 50 kHz/div.

i. Verify that a peak-to-peak deviation of 4 divisions (200 kHz) is obtained. LIMITS: 3.6 to 4.4 divisions.

j. Switch the frequency range to 8 -- 16 MHz with the FM switch at OFF, adjust the VERNIER control to obtain an output frequency of 10.7 MHz.

k. With the FM at INT, adjust the spectrum analyzer to display the signal at a scan width of 0.5 MHz/div.

l. Verify that a peak to peak deviation of 4 divisions (2 MHz) is obtained. LIMITS: 3.6 to 4.4 divisions.

m. Switch the frequency range to 64 – 138 MHz. With the FM switch OFF, adjust the VERNIER control to obtain an output frequency of 98 MHz.

n. With the FM at INT, adjust the spectrum analyzer to display the signal at a scan width of 5 v Hz/div.

o. Verify that a peak-to-peak deviation of 4 divisions (20 MHz) is obtained. LIMITS: 3.6 to 4.4 divisions.

2-63. Frequency Counter Sensitivity Check. To check the sensitivity of the frequency counter circuits, proceed as follows:

a. Connect the signal generator and test equipment as shown in Figure 2-26.

b. Set the signal generator controls as follows:

Control	Setting
AM OFF switch	Depressed
FM OFF switch	Depressed
RESOLUTION Hz switch	1k
COUNTER EXT switch	Depressed
SWEEP switch	OFF
FREQUENCY MHz switch	.125-.25
RF switch	ON
OUTPUT LEVEL attenuator	-20 dBm
OUTPUT control	0 dB indication on OUTPUT LEVEL meter
TUNING control	.125 MHz indication on output frequency indicator

c. Using the TUNING control, tune the signal generator slowly across the band. *The output frequency indicator display should follow the output frequency without erratic indications.*

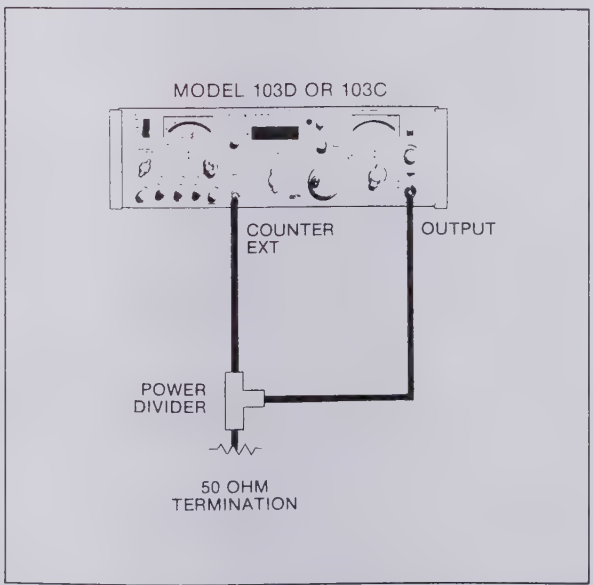


Figure 2-26 Frequency Counter Sensitivity Check, Test Setup

d. Set the FREQUENCY MHz switch to 138-175. Set the OUTPUT LEVEL attenuator to 0 dBm, and adjust the OUTPUT control as required to obtain a -1 dB indication on the OUTPUT LEVEL meter. Using the TUNING control, tune the signal generator slowly across the entire band. *The output frequency indicator display should follow the output frequency with no apparent jumps or erratic indications.*

2-64. RF Leakage Check. Check the signal generator for RF leakage as follows:

a. Set the signal generator controls as follows:

Control	Setting
FREQUENCY MHz switch	64-138
TUNING control	100 MHz indication on output frequency indicator
OUTPUT LEVEL attenuator	-100 dBm
OUTPUT control	+2.5 dBm
FM OFF switch	Depressed
AM OFF switch	Depressed

b. Connect a spectrum analyzer (140T/8552B/8554B) to the OUTPUT connector of the signal generator. Adjust the spectrum analyzer scan width to 20 kHz per division, and the bandwidth to 3 kHz.

c. Adjust the spectrum analyzer for a convenient reference level and display of the output signal from the signal generator.

d. Without disturbing any control settings, disconnect the spectrum analyzer from the signal generator. Connect an RF pickup loop, made up of a three-foot section of 50-ohm coaxial cable with a two-turn, one-inch diameter loop of No. 20 insulated wire, to the spectrum analyzer.

e. Set the signal generator OUTPUT LEVEL attenuator to -120 dBm and adjust the OUTPUT control to produce a 0 dB indication on the OUTPUT LEVEL meter.

f. Probe the outer case surfaces of the signal generator with the pickup loop. *The signal observed on the spectrum analyzer should not exceed the 3 microvolt reference with the pickup loop one inch from any case surface.*

SECTION III
THEORY OF OPERATION

3-1. GENERAL

3-2. The Boonton, Model 103 signal generator is a compact, versatile, solid-state instrument that covers the frequency range of 0.125 to 175 MHz in eleven bands. The primary signal source is a stable, spectrally pure, solid-state VFO, optimized for operation over one of the eleven output bands. Output frequencies for the other ten bands are derived from the VFO output frequency through frequency division or heterodyne techniques. Five separate sweep oscillators are provided as the basic signal sources for sweep frequency operation; the RF derived from the VFO output can be used for marker signals during sweep frequency operation on the 10.7 MHz and 98 MHz ranges only.

3-3. On the Model 103D only, the output frequency of the signal generator can be synchronized to a stable internal reference oscillator, or to an external reference standard by means of a built-in phase lock circuit. Any output frequency within the tuning range of the signal generator can be phase-locked to achieve excellent frequency stability. Phase lock is maintained almost indefinitely under reasonable stable environmental conditions once the signal generator has warmed up. The phase lock feature imposes no restrictions regarding modulation, except to limit FM bandwidth below 50 Hz.

3-4. An internal frequency counter drives a six-digit LED display to provide a direct, continuous display of the output frequency. Selectable resolution capabilities of 1 Hz, 10 Hz, 100 Hz, and 1 kHz are included. This feature provides excellent resettability and accuracy. The internal frequency counter can be switched, if desired, to provide the same frequency measurement capabilities for external signals.

3-5. A 130 dB step attenuator and an adjustable output level control provide a total output level range of -130 to +13 dBm. (The output level can be increased to 3 volts maximum by means of a front panel switch.) The selected output level is automatically maintained throughout the frequency range, independent of frequency tuning, through use of a diode modulator and a feedback loop. The diode modulator also provides the AM modulation capability. FM modulation is provided through use of varactors in the VFO resonant circuit. Frequency sweep is accomplished through use of varactors in the separate sweep oscillator circuits. AM and FM can be used either separately or simultaneously, using internal and external modulating signals.

3-6. SIMPLIFIED BLOCK DIAGRAM
(See figure 3-1.)

3-7. **General.** For purposes of this discussion the circuits of the signal generator have been arbitrarily grouped as follows: VFO circuits, phase lock circuits (Model 103D only), output frequency selection circuits, sweep oscillator circuits, modulation circuits, output circuits, frequency counter circuits, and power supply circuits. The interrelationship of these functional groups is shown in figure 3-1. In order to simplify the discussion, switching details are not covered at this level. For a detailed description of the functional groups, refer to paragraphs 3-27 through 3-96.

3-8. **VFO Circuits.** The basic frequency of the signal generator is developed by a solid-state VFO, which is tunable inductively over a range of 64 to 138 MHz. Varactors in the VFO resonant circuit permit electronic tuning of the VFO for vernier adjustment of the output frequency. The varactors are also used to modulate the VFO for FM applications and, in the Model 103D only, to automatically maintain the selected VFO frequency during phase locked operation. Isolation between the VFO and the output frequency selection circuits is provided by a buffer amplifier. This isolation reduces incidental modulation effects which might otherwise be produced by a change in the impedance of following stages because of loading or AM operations.

3-9. Because the VFO operating range covers only one of the output frequency bands of the signal generator, circuit design has been optimized for operation over this range, and the VFO consequently exhibits excellent frequency stability characteristics and relative freedom from residual FM. Frequency variations due to line voltage changes and supply ripple are minimized through use of a highly regulated and filtered supply voltage. The entire VFO and associated

buffer amplifier are housed in a shielded compartment to minimize RF leakage. Frequency stability can be further improved in the Model 103D through use of the built-in phase lock feature.

3-10. Phase Lock Circuits (Model 103D Only). The phase lock circuits provide means for synchronizing the VFO to a stable internal reference oscillator or to an external frequency standard for applications where extreme frequency stability is essential. Switching between the unlocked and phase locked modes of operation is accomplished easily through actuation of front panel controls. A front panel indicator provides a positive indication of phase lock. When the phase locked mode of operation is selected, the VFO output signal is used to clock an internal counter, which is gated by an extremely stable 1 MHz internal oscillator, or by an external frequency standard. If the frequency of the VFO tends to shift from the phase locked value, an error voltage is developed by the phase lock circuits. This error voltage is applied to the varactors in the VFO resonant circuit, thereby causing an opposite shift in the VFO output frequency to compensate for the original change. The phase lock circuits have a low-pass output with a roll-off starting at approximately 5 Hz, thereby permitting frequency modulation rates as low as 50 Hz.

3-11. Sweep Oscillator Circuits. For sweep frequency operation of the signal generator, five separate sweep oscillator circuits function as the basic frequency generating sources. Selection of the appropriate sweep oscillator is

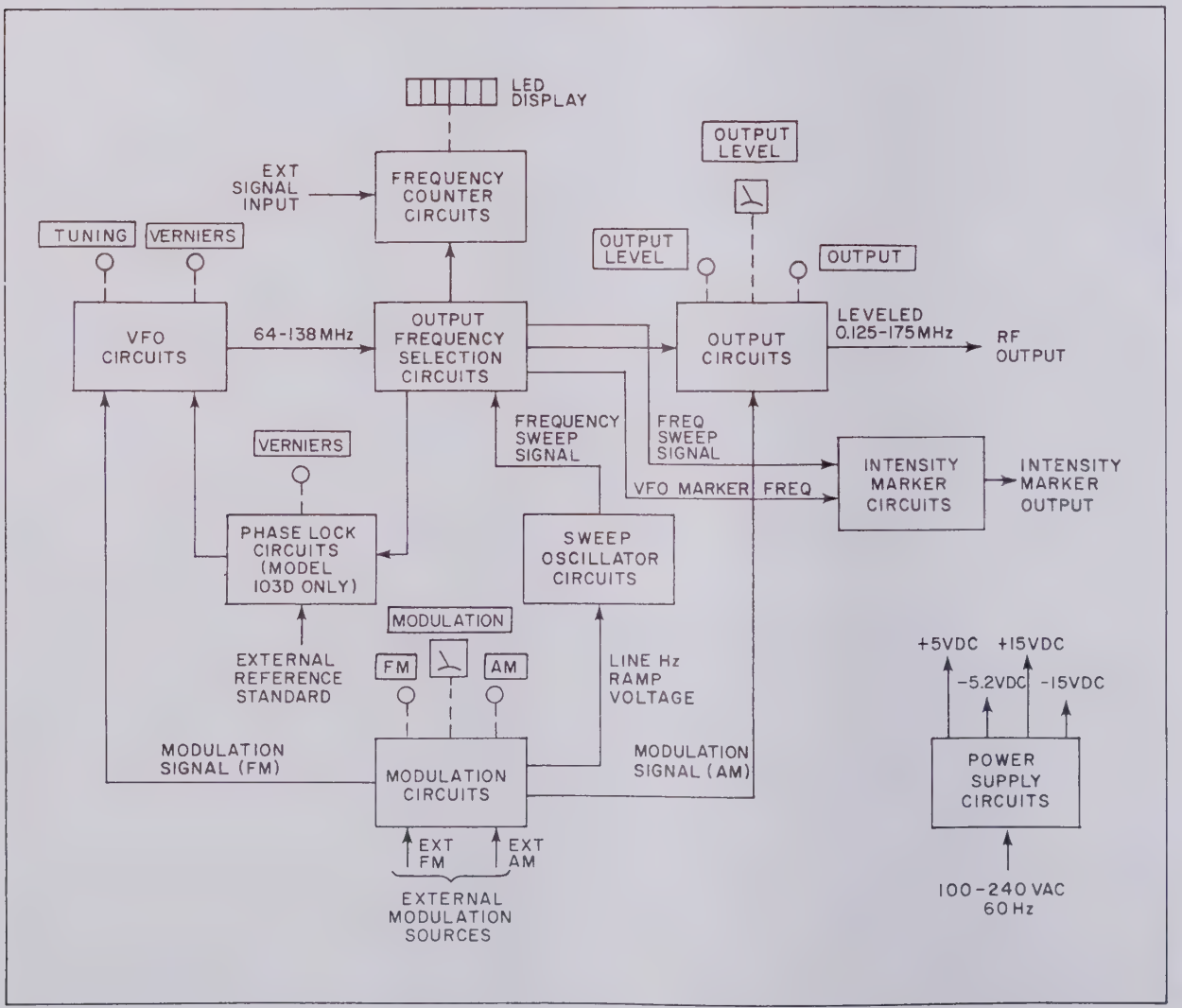


Figure 3-1. Simplified Block Diagram

SECTION III
THEORY OF OPERATION

3-1. GENERAL

3-2. The Boonton, Model 103 signal generator is a compact, versatile, solid-state instrument that covers the frequency range of 0.125 to 175 MHz in eleven bands. The primary signal source is a stable, spectrally pure, solid-state VFO, optimized for operation over one of the eleven output bands. Output frequencies for the other ten bands are derived from the VFO output frequency through frequency division or heterodyne techniques. Five separate sweep oscillators are provided as the basic signal sources for sweep frequency operation; the RF derived from the VFO output can be used for marker signals during sweep frequency operation on the 10.7 MHz and 98 MHz ranges only.

3-3. On the Model 103D only, the output frequency of the signal generator can be synchronized to a stable internal reference oscillator, or to an external reference standard by means of a built-in phase lock circuit. Any output frequency within the tuning range of the signal generator can be phase-locked to achieve excellent frequency stability. Phase lock is maintained almost indefinitely under reasonable stable environmental conditions once the signal generator has warmed up. The phase lock feature imposes no restrictions regarding modulation, except to limit FM bandwidth below 50 Hz.

3-4. An internal frequency counter drives a six-digit LED display to provide a direct, continuous display of the output frequency. Selectable resolution capabilities of 1 Hz, 10 Hz, 100 Hz, and 1 kHz are included. This feature provides excellent resettability and accuracy. The internal frequency counter can be switched, if desired, to provide the same frequency measurement capabilities for external signals.

3-5. A 130 dB step attenuator and an adjustable output level control provide a total output level range of -130 to +13 dBm. (The output level can be increased to 3 volts maximum by means of a front panel switch.) The selected output level is automatically maintained throughout the frequency range, independent of frequency tuning, through use of a diode modulator and a feedback loop. The diode modulator also provides the AM modulation capability. FM modulation is provided through use of varactors in the VFO resonant circuit. Frequency sweep is accomplished through use of varactors in the separate sweep oscillator circuits. AM and FM can be used either separately or simultaneously, using internal and external modulating signals.

3-6. SIMPLIFIED BLOCK DIAGRAM
(See figure 3-1.)

3-7. **General.** For purposes of this discussion the circuits of the signal generator have been arbitrarily grouped as follows: VFO circuits, phase lock circuits (Model 103D only), output frequency selection circuits, sweep oscillator circuits, modulation circuits, output circuits, frequency counter circuits, and power supply circuits. The interrelationship of these functional groups is shown in figure 3-1. In order to simplify the discussion, switching details are not covered at this level. For a detailed description of the functional groups, refer to paragraphs 3-27 through 3-96.

3-8. **VFO Circuits.** The basic frequency of the signal generator is developed by a solid-state VFO, which is tunable inductively over a range of 64 to 138 MHz. Varactors in the VFO resonant circuit permit electronic tuning of the VFO for vernier adjustment of the output frequency. The varactors are also used to modulate the VFO for FM applications and, in the Model 103D only, to automatically maintain the selected VFO frequency during phase locked operation. Isolation between the VFO and the output frequency selection circuits is provided by a buffer amplifier. This isolation reduces incidental modulation effects which might otherwise be produced by a change in the impedance of following stages because of loading or AM operations.

3-9. Because the VFO operating range covers only one of the output frequency bands of the signal generator, circuit design has been optimized for operation over this range, and the VFO consequently exhibits excellent frequency stability characteristics and relative freedom from residual FM. Frequency variations due to line voltage changes and supply ripple are minimized through use of a highly regulated and filtered supply voltage. The entire VFO and associated

buffer amplifier are housed in a shielded compartment to minimize RF leakage. Frequency stability can be further improved in the Model 103D through use of the built-in phase lock feature.

3-10. Phase Lock Circuits (Model 103D Only). The phase lock circuits provide means for synchronizing the VFO to a stable internal reference oscillator or to an external frequency standard for applications where extreme frequency stability is essential. Switching between the unlocked and phase locked modes of operation is accomplished easily through actuation of front panel controls. A front panel indicator provides a positive indication of phase lock. When the phase locked mode of operation is selected, the VFO output signal is used to clock an internal counter, which is gated by an extremely stable 1 MHz internal oscillator, or by an external frequency standard. If the frequency of the VFO tends to shift from the phase locked value, an error voltage is developed by the phase lock circuits. This error voltage is applied to the varactors in the VFO resonant circuit, thereby causing an opposite shift in the VFO output frequency to compensate for the original change. The phase lock circuits have a low-pass output with a roll-off starting at approximately 5 Hz, thereby permitting frequency modulation rates as low as 50 Hz.

3-11. Sweep Oscillator Circuits. For sweep frequency operation of the signal generator, five separate sweep oscillator circuits function as the basic frequency generating sources. Selection of the appropriate sweep oscillator is

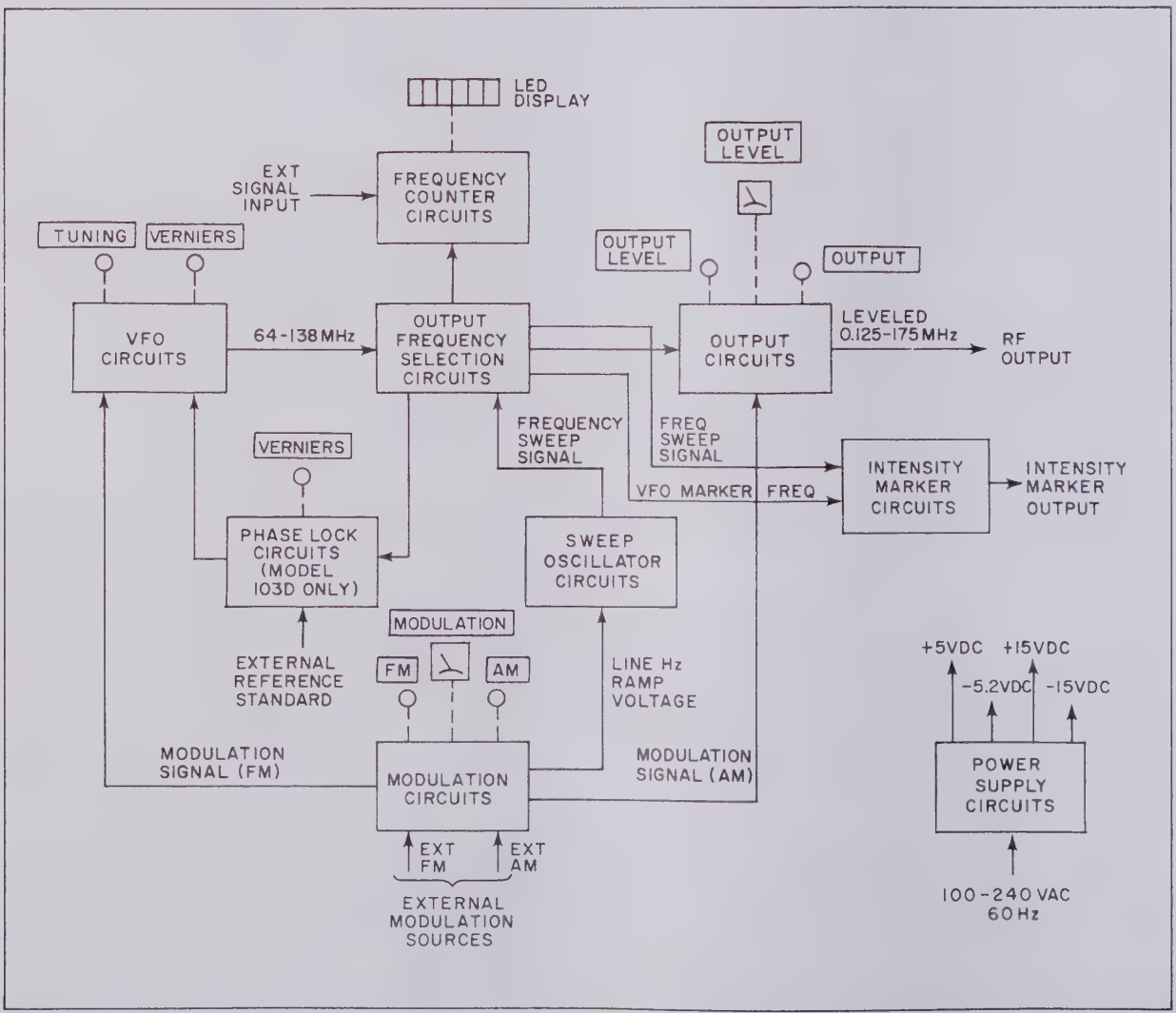


Figure 3-1. Simplified Block Diagram

accomplished automatically based on the FREQUENCY MHz switch setting. During sweep frequency operation, the VFO and output frequency selection circuits can be used to provide a marker frequency (10.7 MHz and 98 MHz ranges only).

3-12. The five sweep oscillators are tuned to the five most commonly used sweep frequencies: 0.262 MHz, 0.455 MHz, 1.2 MHz, 10.7 MHz, and 98 MHz. Slight adjustment of the center frequency of the selected sweep oscillator can be accomplished through adjustment of the front panel vernier tuning control. A varactor in the resonant circuit of each sweep oscillator provides the frequency adjustment capability as well as the sweep modulation capability. The selected sweep oscillator is modulated by a 50-60 Hz ramp voltage supplied by the modulation circuits, or by an externally supplied ramp voltage. The swept frequency output signal is applied to the output frequency selection circuits.

3-13. **Output-Frequency Selection Circuits.** The output-frequency selection circuits consist of all circuit elements required to derive the final output frequency of the signal generator. The output frequencies for bands 1 through 9 are derived from the VFO output frequency through frequency division; the output frequency for band 10 is derived directly from the VFO output frequency; and the output frequency for band 11 is derived by heterodyning the band 9 output frequency with the output of a highly stable, crystal-controlled 106 MHz oscillator. Relays in the output frequency selection circuits function in conjunction with the FREQUENCY MHz switch to provide selection and routing of the RF signals. When sweep frequency operation is selected, the relay circuits also perform the required switching so that the swept frequency of the signal generator is derived from the sweep oscillator circuits, and the RF derived from the VFO output frequency can be used as a marker signal. The selected output RF signals are applied to the intensity marker circuits, the output circuits, and the frequency counter circuits.

3-14. **Intensity Marker Circuits.** The intensity marker circuits provide an intensity marker on the 10.7 MHz and 98 MHz sweep frequency ranges for Z-axis modulation of an oscilloscope. The intensity marker aids in determining the pertinent characteristics of derived response patterns when using the swept frequency mode of operation. The intensity marker circuits compare the sweep signal frequency with a marker frequency that is adjustable by means of the front panel TUNING control. At the point along the oscilloscope trace where the two frequencies are approximately equal an intensity marker appears. The intensity marker signal is coupled to the oscilloscope Z-axis input through the INTENSITY MARKER OUT connector on the rear panel.

3-15. **Output Circuits.** The output circuits control the amplitude of the output signal of the signal generator. Included in the output circuits are a diode modulator, filters, an RF amplifier, a diode demodulator, and output level attenuating and metering circuits. All output circuits, except the filters, are wide-band, covering the full 0.125 to 175 MHz range of the signal generator.

3-16. A diode modulator in the output circuits is used for automatic output leveling and for AM modulation. The output signal amplitude of the signal generator is sampled by the diode demodulator, and a control voltage is fed back to the diode modulator for automatic leveling of the output signal amplitude. The leveling loop virtually eliminates variations in output signal amplitude due to changes in VFO or output frequency selection circuit output levels. The diode demodulator also supplies a DC voltage to the output level metering circuit to provide an indication of the output level of the signal generator.

3-17. The output of the diode modulator is switched to filter circuits by means of PIN diodes. Harmonics and other spurious signals generated as a result of frequency division or heterodyning are suppressed by the appropriate filter. The appropriate filter is switched into the RF signal path automatically at the appropriate point in the tuning range by PIN diodes and a relay. The output signals of the signal generator exhibit excellent spectral purity because of this filtering.

3-18. The filtered RF signals are amplified by a wide-band RF amplifier. The output level of the signal generator is adjustable in 10 dB steps by means of a precision step attenuator, and between attenuator steps by means of the variable OUTPUT control.

3-19. **Modulation Circuits.** The modulation circuits process the audio voltages used for FM and AM applications and a 50-60 Hz ramp voltage used for frequency sweep operation. The modulation mode is selected by means of the front panel MODULATION switches. AM and FM can be used separately or simultaneously. An internal modulation oscillator provides an internal modulation signal capability, and an internal function generator generates the 50-60 Hz ramp voltage used for sweep frequency operation. Distortion, residual and incidental FM, and residual AM are exceptionally low.

3-20. When the AM OFF and FM OFF switches on the front panel are both engaged, the modulation circuits are disabled, and the signal generator provides a CW output. The varactors in the VFO circuit are used only for vernier adjustment of the output frequency (and, in the Model 103D only, for phase lock adjustment of the VFO frequency), and

the diode modulator in the output circuits is used only for automatic leveling. The output of the signal generator is, therefore, a stable, automatically leveled, unmodulated RF signal.

3-21. When the AM INT switch is depressed, the internal modulation oscillator is activated, and the modulation circuits supply an internally generated AM modulating signal to the diode modulator in the output circuits. Any one of five modulating signal frequencies (0.4 kHz, 1 kHz, 3 kHz, 10 kHz, or 19 kHz) can be selected by means of the front panel switch. The amplitude of the modulating voltage (and thus the percentage of modulation) is adjustable by means of the front panel AM control. The MODULATION meter can be switched into the AM portion of the modulation circuits to provide a direct indication of the percentage of modulation. AM is accomplished by varying the effective attenuation of the diode modulator in the output circuits. The diode modulator provides AM modulation capabilities up to 100% with low distortion. Simultaneous FM, using either the internal or an external modulating signal source, is possible. The front panel FM INT or EXT switch must be pressed along with the AM INT switch for such operation. FM is accomplished by applying the modulating signal to the varactors in the VFO. The calibrated full-scale peak deviation for FM is adjustable from 3 kHz to 300 kHz, in five steps, by means of a front panel switch. The actual deviation is adjustable up to the selected full-scale value by means of the FM control. The MODULATION meter can be switched into the FM portion of the modulation circuits to provide a direct indication of actual deviation. Because FM is accomplished at the VFO and the VFO output frequency is subject to frequency division in the output frequency selection circuits, the amplitude of the modulating signal is automatically adjusted for the different output bands by means of attenuating networks switched into the FM circuitry by means of the FREQUENCY MHz switch. This feature ensures that frequency deviation will remain constant, regardless of band changes.

3-22. When the FM INT switch is depressed, the internal modulation oscillator provides the modulating signal for the FM portion. Simultaneous AM, using either the internal or an external modulating signal source, is possible by pressing the INT AM or EXT AM switches.

3-23. If both the AM EXT and FM EXT switches are depressed, the internal modulation oscillator is disabled. AM and FM can be used, either individually or simultaneously, but modulating signals from external sources must be provided for both AM and FM. Except for the modulating signal sources, operation of the AM and FM portions is identical to that described in paragraph 3-20.

NOTE

When the FM EXT switch is pressed, the MOD FREQ kHz switch must be set to any position other than the LINE Hz RAMP position to 'enable' the external source.

3-24. For sweep frequency operation, either an internally generated 50-60 Hz ramp voltage or an externally supplied ramp voltage may be used to modulate the selected sweep oscillator. To use the internal ramp voltage for sweep frequency operation, the SWEEP switch must be set to the ON or the MKR position, the DEVIATION kHz switch to the 300 position (to obtain maximum full scale deviation), the MOD FREQ kHz switch to the LINE Hz RAMP position, and the FM INT switch must be pressed to activate a function generator in the modulation circuits. The function generator generates a 50-60 Hz ramp voltage, which is processed by a portion of the FM modulation circuits; this ramp voltage, after processing, is applied to a varactor in the selected sweep oscillator circuit to cause frequency sweep of the sweep oscillator output signal. To use an external ramp voltage for sweep frequency operation, the FM EXT switch must be depressed, the MOD FREQ kHz switch must be set to any position other than the LINE Hz RAMP position, and the DEVIATION kHz switch should be set to the 300 position. The internal function generator is disabled and an external ramp voltage applied to the front panel 1V FS connector is processed by a portion of the FM modulation circuits, and is applied to the varactor in the selected sweep oscillator circuit to produce the frequency sweep operation.

3-25. **Frequency Counter Circuits.** The frequency counter circuits provide a continuous, unambiguous display of the output frequency of the signal generator, or they may be used to provide a display of the frequency of an external signal source. Resolutions of 1 Hz, 10 Hz, 100 Hz, and 1 kHz are selectable by means of a front panel switch. (The 1 Hz resolution is usable only for frequencies up to 16 MHz, maximum.) The frequency range for external signals is 5 Hz to 175 MHz; sensitivity of the external signal measurement circuits is 100 millivolts.

3-26. **Power Supply Circuits.** The power supply circuits develop the DC voltages required for operation of the internal circuits of the signal generator. Four separate rectifier-regulator circuits are employed, providing regulated output voltages of +5 volts, -5.2 volts, +15 volts, and -15 volts. The four supplies are regulated and well filtered in order to minimize residual FM and enhance the stability of the signal generator. The power supply circuits are designed for operation from a 100, 120, 220, or 240 volt, 50 Hz to 400 Hz,

accomplished automatically based on the FREQUENCY MHz switch setting. During sweep frequency operation, the VFO and output frequency selection circuits can be used to provide a marker frequency (10.7 MHz and 98 MHz ranges only).

3-12. The five sweep oscillators are tuned to the five most commonly used sweep frequencies: 0.262 MHz, 0.455 MHz, 1.2 MHz, 10.7 MHz, and 98 MHz. Slight adjustment of the center frequency of the selected sweep oscillator can be accomplished through adjustment of the front panel vernier tuning control. A varactor in the resonant circuit of each sweep oscillator provides the frequency adjustment capability as well as the sweep modulation capability. The selected sweep oscillator is modulated by a 50-60 Hz ramp voltage supplied by the modulation circuits, or by an externally supplied ramp voltage. The swept frequency output signal is applied to the output frequency selection circuits.

3-13. **Output-Frequency Selection Circuits.** The output-frequency selection circuits consist of all circuit elements required to derive the final output frequency of the signal generator. The output frequencies for bands 1 through 9 are derived from the VFO output frequency through frequency division; the output frequency for band 10 is derived directly from the VFO output frequency; and the output frequency for band 11 is derived by heterodyning the band 9 output frequency with the output of a highly stable, crystal-controlled 106 MHz oscillator. Relays in the output frequency selection circuits function in conjunction with the FREQUENCY MHz switch to provide selection and routing of the RF signals. When sweep frequency operation is selected, the relay circuits also perform the required switching so that the swept frequency of the signal generator is derived from the sweep oscillator circuits, and the RF derived from the VFO output frequency can be used as a marker signal. The selected output RF signals are applied to the intensity marker circuits, the output circuits, and the frequency counter circuits.

3-14. **Intensity Marker Circuits.** The intensity marker circuits provide an intensity marker on the 10.7 MHz and 98 MHz sweep frequency ranges for Z-axis modulation of an oscilloscope. The intensity marker aids in determining the pertinent characteristics of derived response patterns when using the swept frequency mode of operation. The intensity marker circuits compare the sweep signal frequency with a marker frequency that is adjustable by means of the front panel TUNING control. At the point along the oscilloscope trace where the two frequencies are approximately equal an intensity marker appears. The intensity marker signal is coupled to the oscilloscope Z-axis input through the INTENSITY MARKER OUT connector on the rear panel.

3-15. **Output Circuits.** The output circuits control the amplitude of the output signal of the signal generator. Included in the output circuits are a diode modulator, filters, an RF amplifier, a diode demodulator, and output level attenuating and metering circuits. All output circuits, except the filters, are wide-band, covering the full 0.125 to 175 MHz range of the signal generator.

3-16. A diode modulator in the output circuits is used for automatic output leveling and for AM modulation. The output signal amplitude of the signal generator is sampled by the diode demodulator, and a control voltage is fed back to the diode modulator for automatic leveling of the output signal amplitude. The leveling loop virtually eliminates variations in output signal amplitude due to changes in VFO or output frequency selection circuit output levels. The diode demodulator also supplies a DC voltage to the output level metering circuit to provide an indication of the output level of the signal generator.

3-17. The output of the diode modulator is switched to filter circuits by means of PIN diodes. Harmonics and other spurious signals generated as a result of frequency division or heterodyning are suppressed by the appropriate filter. The appropriate filter is switched into the RF signal path automatically at the appropriate point in the tuning range by PIN diodes and a relay. The output signals of the signal generator exhibit excellent spectral purity because of this filtering.

3-18. The filtered RF signals are amplified by a wide-band RF amplifier. The output level of the signal generator is adjustable in 10 dB steps by means of a precision step attenuator, and between attenuator steps by means of the variable OUTPUT control.

3-19. **Modulation Circuits.** The modulation circuits process the audio voltages used for FM and AM applications and a 50-60 Hz ramp voltage used for frequency sweep operation. The modulation mode is selected by means of the front panel MODULATION switches. AM and FM can be used separately or simultaneously. An internal modulation oscillator provides an internal modulation signal capability, and an internal function generator generates the 50-60 Hz ramp voltage used for sweep frequency operation. Distortion, residual and incidental FM, and residual AM are exceptionally low.

3-20. When the AM OFF and FM OFF switches on the front panel are both engaged, the modulation circuits are disabled, and the signal generator provides a CW output. The varactors in the VFO circuit are used only for vernier adjustment of the output frequency (and, in the Model 103D only, for phase lock adjustment of the VFO frequency), and

the diode modulator in the output circuits is used only for automatic leveling. The output of the signal generator is, therefore, a stable, automatically leveled, unmodulated RF signal.

3-21. When the AM INT switch is depressed, the internal modulation oscillator is activated, and the modulation circuits supply an internally generated AM modulating signal to the diode modulator in the output circuits. Any one of five modulating signal frequencies (0.4 kHz, 1 kHz, 3 kHz, 10 kHz, or 19 kHz) can be selected by means of the front panel switch. The amplitude of the modulating voltage (and thus the percentage of modulation) is adjustable by means of the front panel AM control. The MODULATION meter can be switched into the AM portion of the modulation circuits to provide a direct indication of the percentage of modulation. AM is accomplished by varying the effective attenuation of the diode modulator in the output circuits. The diode modulator provides AM modulation capabilities up to 100% with low distortion. Simultaneous FM, using either the internal or an external modulating signal source, is possible. The front panel FM INT or EXT switch must be pressed along with the AM INT switch for such operation. FM is accomplished by applying the modulating signal to the varactors in the VFO. The calibrated full-scale peak deviation for FM is adjustable from 3 kHz to 300 kHz, in five steps, by means of a front panel switch. The actual deviation is adjustable up to the selected full-scale value by means of the FM control. The MODULATION meter can be switched into the FM portion of the modulation circuits to provide a direct indication of actual deviation. Because FM is accomplished at the VFO and the VFO output frequency is subject to frequency division in the output frequency selection circuits, the amplitude of the modulating signal is automatically adjusted for the different output bands by means of attenuating networks switched into the FM circuitry by means of the FREQUENCY MHz switch. This feature ensures that frequency deviation will remain constant, regardless of band changes.

3-22. When the FM INT switch is depressed, the internal modulation oscillator provides the modulating signal for the FM portion. Simultaneous AM, using either the internal or an external modulating signal source, is possible by pressing the INT AM or EXT AM switches.

3-23. If both the AM EXT and FM EXT switches are depressed, the internal modulation oscillator is disabled. AM and FM can be used, either individually or simultaneously, but modulating signals from external sources must be provided for both AM and FM. Except for the modulating signal sources, operation of the AM and FM portions is identical to that described in paragraph 3-20.

NOTE

When the FM EXT switch is pressed, the MOD FREQ kHz switch must be set to any position other than the LINE Hz RAMP position to 'enable' the external source.

3-24. For sweep frequency operation, either an internally generated 50-60 Hz ramp voltage or an externally supplied ramp voltage may be used to modulate the selected sweep oscillator. To use the internal ramp voltage for sweep frequency operation, the SWEEP switch must be set to the ON or the MKR position, the DEVIATION kHz switch to the 300 position (to obtain maximum full scale deviation), the MOD FREQ kHz switch to the LINE Hz RAMP position, and the FM INT switch must be pressed to activate a function generator in the modulation circuits. The function generator generates a 50-60 Hz ramp voltage, which is processed by a portion of the FM modulation circuits; this ramp voltage, after processing, is applied to a varactor in the selected sweep oscillator circuit to cause frequency sweep of the sweep oscillator output signal. To use an external ramp voltage for sweep frequency operation, the FM EXT switch must be depressed, the MOD FREQ kHz switch must be set to any position other than the LINE Hz RAMP position, and the DEVIATION kHz switch should be set to the 300 position. The internal function generator is disabled and an external ramp voltage applied to the front panel 1V FS connector is processed by a portion of the FM modulation circuits, and is applied to the varactor in the selected sweep oscillator circuit to produce the frequency sweep operation.

3-25. **Frequency Counter Circuits.** The frequency counter circuits provide a continuous, unambiguous display of the output frequency of the signal generator, or they may be used to provide a display of the frequency of an external signal source. Resolutions of 1 Hz, 10 Hz, 100 Hz, and 1 kHz are selectable by means of a front panel switch. (The 1 Hz resolution is usable only for frequencies up to 16 MHz, maximum.) The frequency range for external signals is 5 Hz to 175 MHz; sensitivity of the external signal measurement circuits is 100 millivolts.

3-26. **Power Supply Circuits.** The power supply circuits develop the DC voltages required for operation of the internal circuits of the signal generator. Four separate rectifier-regulator circuits are employed, providing regulated output voltages of +5 volts, -5.2 volts, +15 volts, and -15 volts. The four supplies are regulated and well filtered in order to minimize residual FM and enhance the stability of the signal generator. The power supply circuits are designed for operation from a 100, 120, 220, or 240 volt, 50 Hz to 400 Hz,

AC power source. A switch on the rear panel of the signal generator alters circuit connections to accomodate the selected AC voltage sources.

NOTE

Input current at 100 or 120 volts is approximately twice that at 220 or 240 volts; therefore, the line fuse must be changed when switching from a 100 or 120 volt AC source to a 220 or 240 volt AC source, or vice versa.

3-27. DETAILED THEORY OF OPERATION, VFO CIRCUITS.

(See figure 3-2.)

NOTE

Figure 3-2 shows the VFO circuits in the Model 103D. The Model 103C contains no phase lock circuits; otherwise, the VFO circuits are the same as shown.

3-28. The basic frequency source of the signal generator is the VFO, which is a highly stable, solid-state oscillator, optimized for operation over the frequency range of 64 to 138 MHz. Main tuning is accomplished by means of a variable inductor, thereby reducing microphonism to a very low level. Varactors in the resonant circuit of the VFO provide FM, phase lock (Model 103D only), and electronic fine-tuning capabilities. The effective capacitance of the varactors is controlled by a DC bias voltage that is adjustable by means of the unlock VERNIER control, by the phase lock correction signal (Model 103D only), and by the FM modulation signal. A variable capacitor tracked to the TUNING control maintains the deviation sensitivity of the varactors essentially constant over the entire tuning range of the VFO.

3-29. When the Model 103D is operating in the phase locked mode, adjustment of the unlock VERNIER control generally does not cause loss of lock or change of frequency because the phase lock circuits have sufficient range to compensate for such adjustment. However, adjustment of the unlock VERNIER control will reduce the dynamic range of the phase lock loop in one direction; therefore, the control should not be adjusted after phase lock is achieved.

3-30. The RF signal generated by the VFO is applied to a buffer amplifier, mounted inside the VFO housing. The buffer amplifier provides isolation between the VFO and the following output frequency selection circuits. This isolation

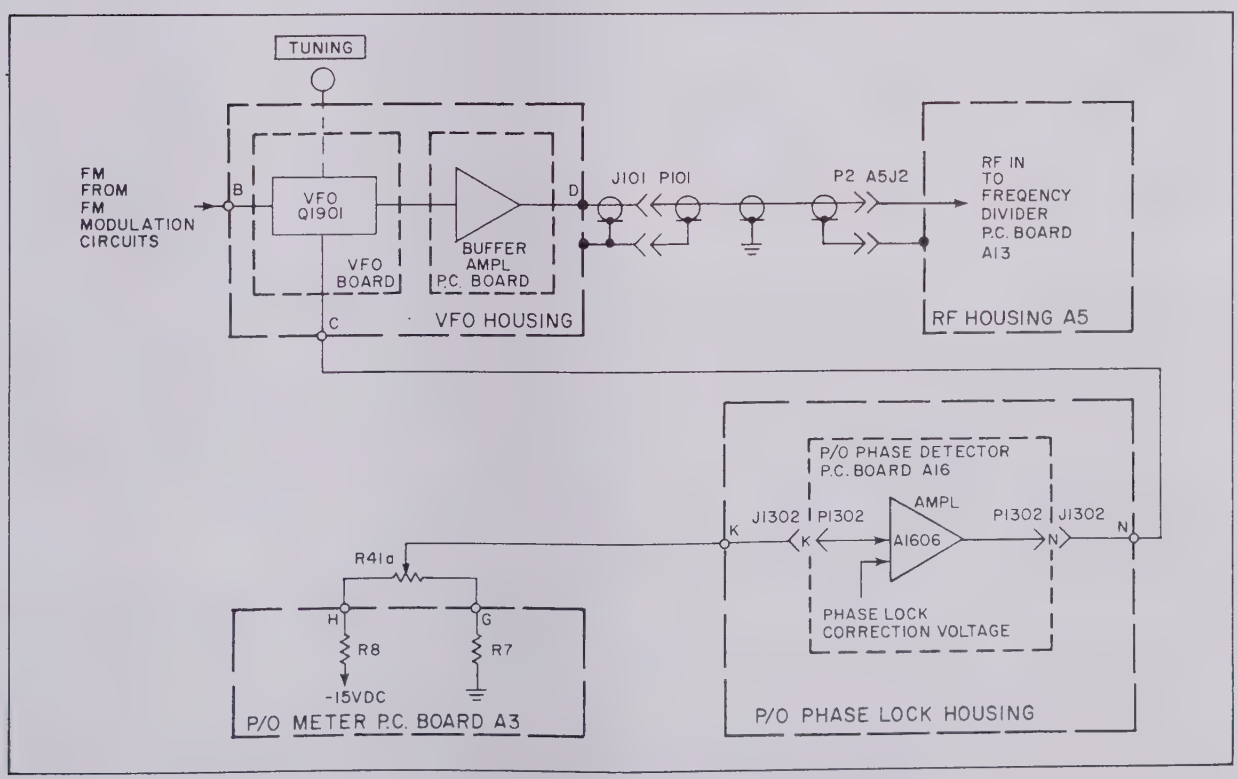


Figure 3-2. VFO Circuits (Model 103D), Detailed Block Diagram

reduces incidental modulation effects which might be produced by changes in the input impedance of the output circuits as a result of leveling and AM operations. The buffer amplifier supplies a 64-138 MHz signal to the frequency divider printed circuit board A13 in the RF housing. The buffer amplifier circuits, as well as all VFO circuits, are completely shielded to minimize RF radiation.

3-31. DETAILED THEORY OF OPERATION, PHASE LOCK CIRCUITS (MODEL 103D ONLY).

(See figure 3-3.)

3-32. For the phase locked mode of operation, the Model 103D uses an individual counter and time base, together with a phase detector, filter, and amplifier. Selection of the phase locked mode, or the unlocked mode, is accomplished by means of the front panel LOCK and UNLOCK pushbuttons, respectively.

3-33. In the unlocked mode of operation, monostable multivibrator IC1704 is in its normal quiescent state, and the output levels of the multivibrator establish circuit conditions for the unlocked mode. The VFO frequency is divided by 16 and is then applied to the counter circuits. The counter circuits are gated by 50 Hz counter gate pulses. These counter gate pulses are derived from the stable 1 MHz output of oscillator Y1501 (INT/EXT switch set to the INT position) or from an external 1 MHz reference signal applied to connector J8 (INT/EXT switch set to the EXT position). The 1 MHz reference frequency is divided by dividers IC1502 through IC1506 to provide a 50 Hz counter gate signal. The dividers also generate a 10 Hz output signal that is used to flash the front panel phase lock indicator if phase lock is lost during phase locked operation.

3-34. During the count gate interval, the pulses derived from the VFO output are counted by counters IC1707, IC1710, IC1713, IC1715, and IC1718. At the end of the count gate interval the count is loaded into latches IC1706, IC1709, IC1712, IC1714, and IC1717, and the counters are cleared for the next cycle of operation. The latch output lines are so selected that the complement of the count appears on the output lines. As long as the Model 103D is operated in the unlocked mode, this action repeats with each counter gate pulse; therefore, at any time, the complement of the counter output count is stored in the latches.

3-35. When the LOCK pushbutton is pressed, monostable multivibrator IC1704 can be triggered by the 50 Hz counter gate pulses, and the phase locked circuit configuration is established. The latches contain the complement of the last count. When a full count condition is reached in the counters, a load pulse is generated, and the complement count from the latches is loaded into the counter. The counter then counts the same number of input pulses as it had in the unlatched mode, at which point a full-count condition is again reached and another load pulse is generated. To illustrate this process, consider a decade counter that had counted to 4. The complement of that count would be 6, and this 6 count would be stored in the corresponding latch and loaded into the counter when a load pulse occurred. The counter could then count only 4 pulses (the same number as the original count) before the full-count condition again occurred and another load pulse was generated. Note that termination of the count in the counters is no longer determined by the counter gate pulse duration, but is determined instead by the full-count condition. If the frequency of the input pulses to the counter remains constant, the period of the load pulses remains constant; however, if the frequency of the input pulses tends to shift, the period of the load pulses shifts correspondingly, and more or fewer load pulses tend to be generated in any fixed time period.

3-36. The load pulses are compared with the counter gate pulses in the phase detector. If the period of the load pulses tends to shift, an error voltage is generated. This error voltage is amplified, integrated, and filtered, and is then applied to the varactor in the VFO tuning circuit with the correct polarity and magnitude to correct the VFO frequency to that existing at the time that the phase locked mode was established. Filtering of the error voltage is of the low-pass type, with roll-off starting at approximately 5 Hz. This permits frequency modulation rates as low as 50 Hz with phase locked operation. A null type filter, tuned to 50 Hz, is also incorporated to reduce undesirable effects when the carrier is modulated at or near 50 Hz. Differential amplifier A1606 permits use of the same varactors in the VFO tuned circuit for frequency vernier purposes in the unlocked mode and for frequency correction in the phase locked mode. The 1 MHz crystal oscillator from which the counter gate pulses are derived is adjustable over a range of approximately 20 ppm to permit locking at all frequencies in the tuning range of the Model 103D. When the internal 1 MHz reference signal is selected, this same reference signal is available at connector J8 for possible use in synchronizing other instruments.

3-37. The phase lock indicator drive circuits supply a drive signal to the front panel phase lock indicator. If phase lock is lost, the error voltage exceeds a predetermined value, and the 10 Hz signal from divider IC1506 is gated through to cause blinking of the front panel phase lock indicator. As long as phase lock is maintained, the 10 Hz signal is blocked, and the front panel phase lock indicator is lighted continuously.

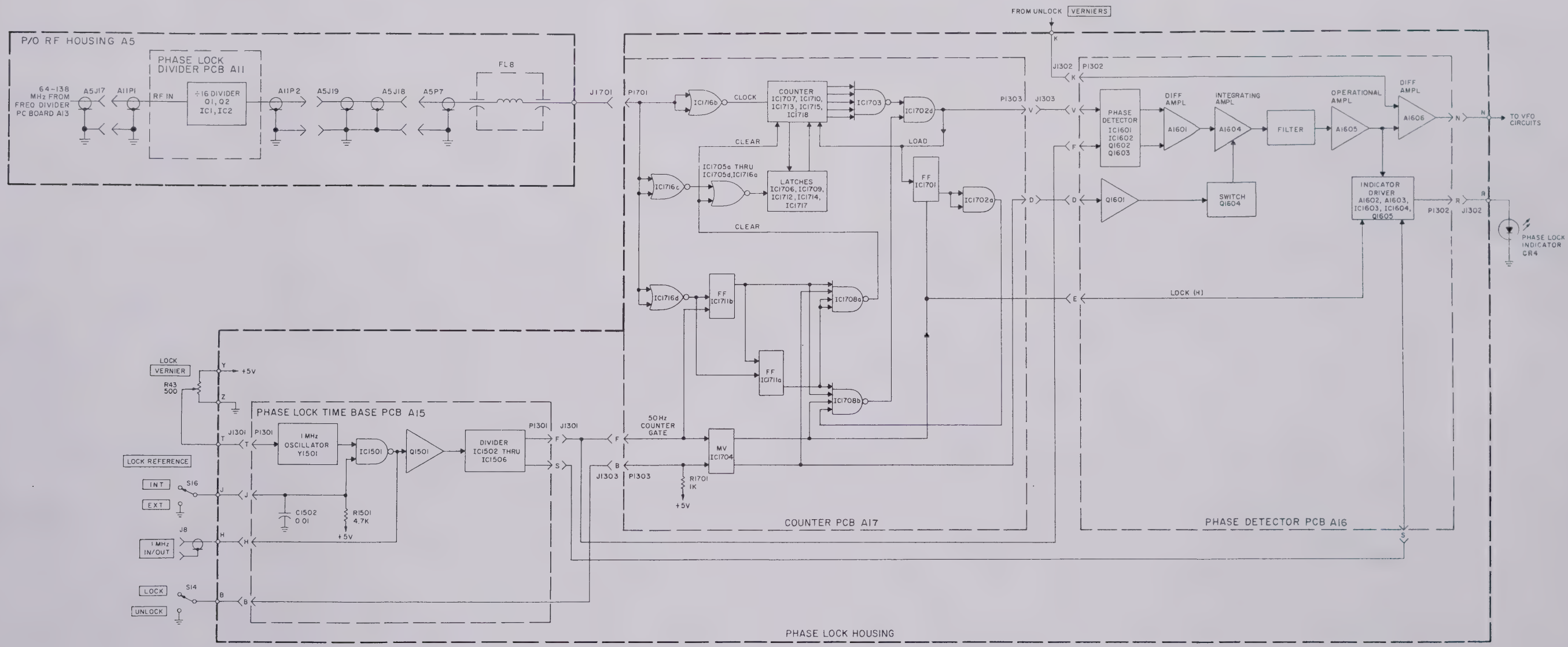


Figure 3-3. Phase Lock Circuits (Model 103D), Detailed Block Diagram

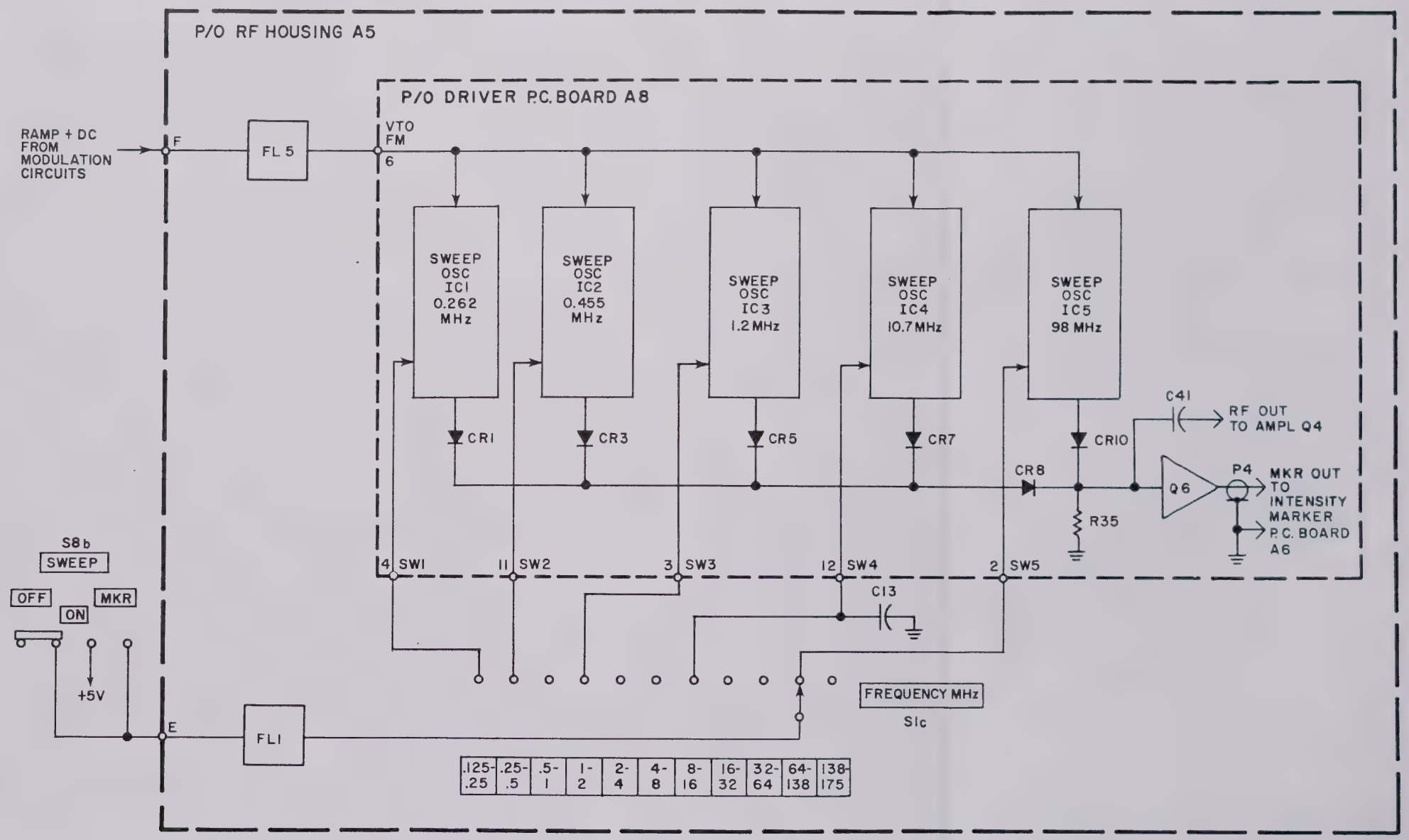


Figure 3-4. Sweep Oscillator Circuits, Detailed Block Diagram

3-38. DETAILED THEORY OF OPERATION, SWEEP OSCILLATOR CIRCUITS.

(See figure 3-4.)

3-39. The VFO is not used as the basic frequency source for sweep frequency operation; five separate sweep oscillators are provided. The VFO can be used as the basic frequency source for marker signals during sweep frequency operation, if desired. The five sweep oscillators are basically similar. Their center frequencies are adjusted by the effective value of inductance and capacitance in their resonant circuits. Varactors in the resonant circuits enable slight adjustment of the center frequency (by means of the unlock VERNIER control), and frequency sweep modulation by the ramp voltage supplied from the modulation circuits.

3-40. Sweep oscillator A8IC1, which operates at a center frequency of 0.262 MHz, is activated through SWEEP switch S8 when the FREQUENCY MHz switch is set to band 1. The line frequency ramp, superimposed on DC, is applied to a varactor in the resonant circuit through filter A5FL15. The DC establishes the center frequency of the sweep oscillator, and the ramp-voltage frequency modulates the sweep oscillator output.

3-41. Sweep oscillator A8IC2 is activated through the SWEEP switch when the FREQUENCY MHz switch is set to band 2; sweep oscillator A12IC2 when the switch is set to band 4; sweep oscillator A8IC4 when the switch is set to band 7; and sweep oscillator A8IC5 when the switch is set to band 10. These four sweep oscillators are tuned to center frequencies of 0.455 MHz, 1.2 MHz, 10.7 MHz, and 98 MHz, respectively. Fine-frequency tuning and modulation are accomplished by the DC and ramp voltages in the same manner as in the circuit of sweep oscillator A8IC1. The output of the active sweep oscillator is coupled to the output-frequency selection circuits and to the intensity marker circuits.

3-42. DETAILED THEORY OF OPERATION, OUTPUT-FREQUENCY SELECTION CIRCUITS.

(See figures 3-5 and 3-6.)

3-43. General. The output-frequency selection circuits develop the output frequencies of the signal generator from the 64-138 MHz output signal of the VFO circuits for non-sweep operation, and select the frequency swept output of the sweep oscillator circuits for frequency sweep operation. The signal generator output-frequency ranges for bands 1 through 9 are derived from the VFO output range through frequency division. The output-frequency range for band 10 is covered fully by the VFO output range; therefore, no frequency division or conversion is required. For band 11, the output-frequency range is obtained by heterodyning a 32-69 MHz RF signal, derived from the VFO output through frequency division, with an internally generated 106 MHz RF signal.

3-44. Frequency Divider Printed-Circuit Board. (See figure 3-5.) The frequency divider circuits consist of a dual flip-flop, two programmable frequency dividers, another flip-flop, and associated gate circuits. Each flip-flop divides its input frequency by two. The programmable dividers divide their applied frequency by a ratio determined by a code supplied to their data inputs through the FREQUENCY MHz switch; the ratio varies from 1 to 64, depending upon the frequency band selected. The gate circuits, which are also activated through the FREQUENCY MHz switch, select the output signal from the appropriate divider circuit for application through transformer A13T1 and relay A13K1 to the connector A13P3.

3-45. When the FREQUENCY MHz switch is set to bands 1 through 7, the output of flip-flop A13IC7 is activated through gate A13IC4d by a logic high (ground) applied through FREQUENCY MHz switch section A5S1b, and the RF input signal is acted upon by all frequency divider circuits. The RF input signal is divided by two by flip-flop A13IC3a, and again by two by flip-flop A13IC3b before being applied to the programmable dividers. FREQUENCY MHz switch section A5S1a supplies the code that determines the division ratio of programmable dividers A13IC5 and A13IC6. On band 7, the division ratio is one, and it doubles for each successively lower switch position down to band 1, where the division ratio is 64. The output frequency of the programmable dividers is further divided by two by flip-flop A13IC7 before being supplied to the output transformer.

3-46. On band 8, a logic high is supplied through FREQUENCY MHz switch section A5S1b to gates A13IC4a and A13IC4b. Gate A13IC4b opens the signal path to the programmable dividers, and gate A13IC4a activates the output of flip-flop A13IC3b. The RF input frequency is then divided by two by flip-flop A13IC3a and again by two by flip-flop A13IC3b before being supplied to the output transformer.

3-47. On bands 9 and 11, a logic high is supplied through FREQUENCY MHz switch section A13S1b to gates A13IC1c and A13IC2c. Gate A13IC2c opens the signal path to flip-flop A13IC3b, and gate A13IC1c activates the output of flip-flop A13IC3a for application to the output transformer. The RF input signal is thereby divided by two on bands 9 and 11. On band 10, no frequency division is required; the RF input signal is supplied to the output transformer through gate A13IC2a, which is activated by a logic high

supplied to gate A13IC1a from FREQUENCY MHz switch section A5S1b.

3-48. The frequency divider printed-circuit board also contains two relay circuits that are used for switching the RF output and counter circuit connections for normal, sweep, and marker operation. When the SWEEP switch is set to the OFF position, both relays are deenergized. The RF output signal of transformer A13T1 is connected through contacts of relay A13K1 to driver printed-circuit board A8, and the output signal of the counter amplifier on the driver printed-circuit board is routed through the contacts of relay A13K2 to the prescaler printed-circuit board. When the SWEEP switch is set to the ON position, +5 volts is supplied through the switch to the VTO ENABLE input, thereby energizing relay A13K1. The contacts of relay A13K1 disconnect the RF output signal of the frequency divider circuits from the driver printed-circuit board, and the RF input signal to the driver printed-circuit board is supplied by the sweep oscillators instead. The counter amplifier on the driver printed-circuit board then applies the sweep oscillator frequency through relay A13K2 to the prescaler board. When the SWEEP switch is set to the MKR position, the MKR GROUND signal is activated through the switch, and relay A13K2 is also energized. The RF output signal of the frequency divider circuits then is supplied through connector P4 to intensity marker printed-circuit board A6, and a second output of gate A13IC1e is supplied through relay A13K2 to the prescaler board.

3-49. **Driver Printed-Circuit Board.** (See figure 3-6.) The driver printed circuit board contains a frequency conversion circuit for band 11, various relay control circuits and amplifiers used for signal selection and routing, and the sweep oscillator circuits described in paragraphs 3-38 through 3-41. Input to the driver printed circuit board consists of the RF output signal from the frequency divider printed circuit board. The output of the driver printed circuit board is applied to the output circuits and to the frequency-counter circuits.

3-50. On bands 1 through 10, the final output frequency of the signal generator for non-sweep operation is developed by the frequency divider printed-circuit board. On band 11, the output frequency of the signal generator is developed by heterodyning the 32-69 MHz RF output from the frequency divider printed-circuit board with a crystal-controlled, 106 MHz RF signal. The 106 MHz signal is generated by crystal oscillator A8Q1. The 106 MHz signal is applied to mixer A8Z1. When the FREQUENCY MHz switch is set to the 138-175 MHz position (band 11), relays A8K1 and A8K2 are not energized. The contacts of relay A8K1 apply a 32-69 MHz signal from the frequency divider printed-circuit board to mixer A8Z1, and a 138-175 MHz output is developed by the mixer through heterodyne action. This 138-175 MHz signal is amplified by amplifier A8Q2, and is then applied to RF amplifier A8Q4 through the contacts of relays A8K2 and A8K3. (Relay A8K3 is energized from the +15 volt DC supply unless SWEEP switch S8c is set to the MKR position.) The RF signal is amplified by RF amplifier A8Q4 and is then applied to the modulator circuit on the output circuit board. The output of band 11 RF amplifier A8Q2 is also applied to the prescaler printed circuit board in the frequency counter circuits through counter amplifier A8Q3-A8Q5.

3-51. On bands 1 through 10, relays A8K1 and A8K2 are energized through FREQUENCY MHz switch section A5S1e from the +5 volt DC supply. Relay A8K3 is energized through resistor A8R36 from the +15 volt DC supply. The frequency converter circuit is then switched out of the RF signal path, and the RF signal from the frequency divider printed-circuit board is applied to driver amplifier A8Q4 through the contacts of relays A8K1, A8K2, and A8K3. The same signal is also supplied to the prescaler printed-circuit board through counter amplifier A8Q3-A8Q5 (internal counter operation only).

3-52. For sweep frequency operation, SWEEP switch S8 is set to the ON (no marker) or the MKR position. Switch section S8b energizes relay A8K4 from the +5 volt DC supply and the signals from the active sweep oscillator on the driver printed circuit board are applied to the modulator circuit on the output printed-circuit board through the contacts of relay A8K4 and RF amplifier A8Q4. If the SWEEP switch is set to the ON position, the RF signal from the frequency divider printed-circuit board is interrupted by operation of relay A13K1 on the frequency divider printed-circuit board. The output of the signal generator then consists of the swept RF signal generated by the selected sweep oscillator. Relay A8K3 is still energized; therefore, the RF signal from the sweep oscillator is applied to the frequency-counter circuits through the contacts of the relay counter amplifier A8Q3-A8Q5, and the contacts of relay A13K2 on the frequency divider printed-circuit board.

3-53. If the SWEEP switch is set to the MKR position, the return path for relay A13K2 is completed through diode A13CR2 and switch section S8c, and relay A13K2 is energized. Switch section S8c also grounds the high end of relay A8K3, thereby deenergizing this relay. Relay A8K4 is energized through switch section S8b. With this relay configuration, the RF signal from the selected sweep oscillator is supplied to the modulator circuit of the output printed-circuit board through the contacts of relay A8K4 and RF amplifier A8Q4. The RF signal from the frequency divider printed-circuit board (which now serves as the marker signal)

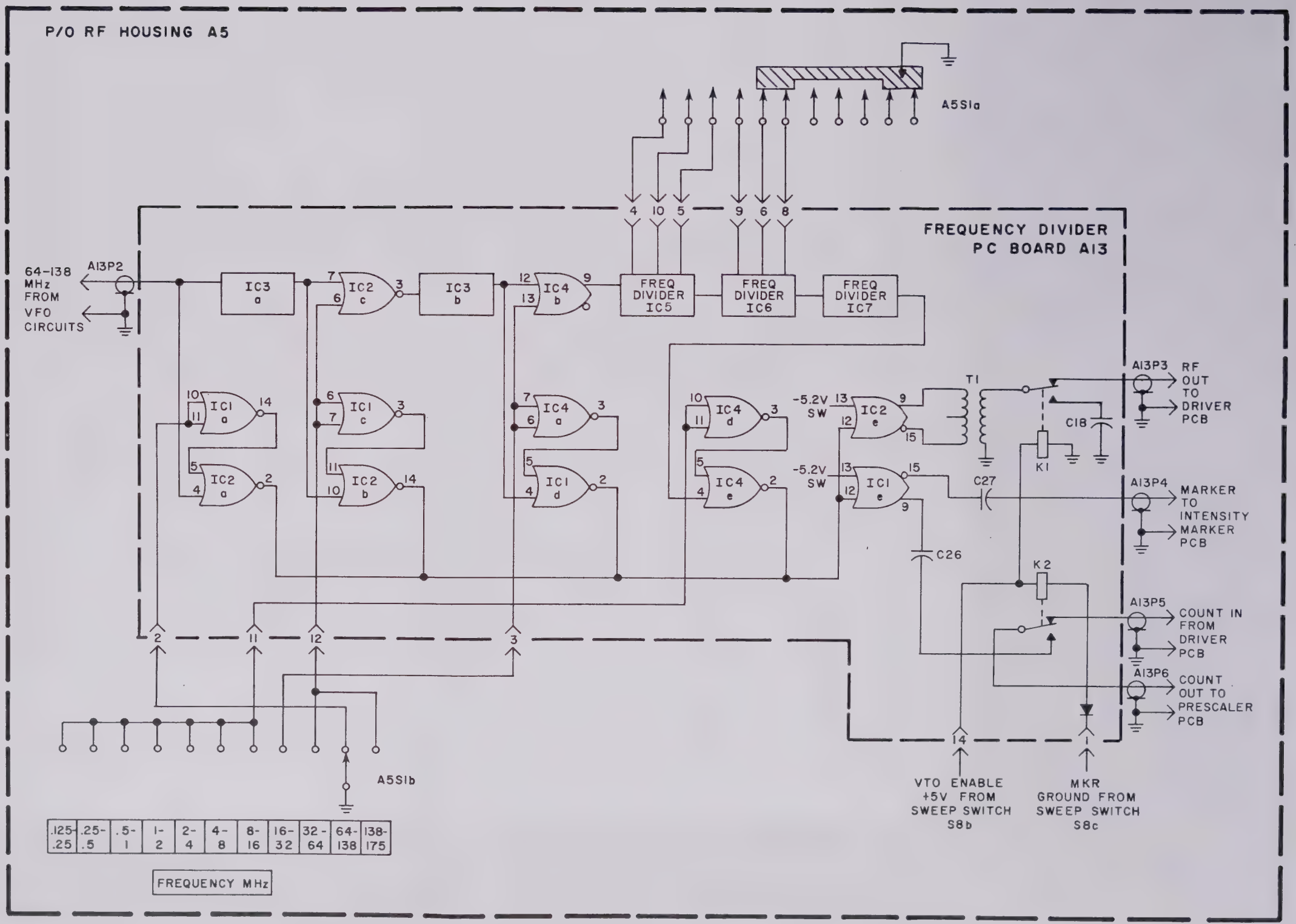


Figure 3-5. Frequency Divider Printed Circuit Board A13, Detailed Block Diagram

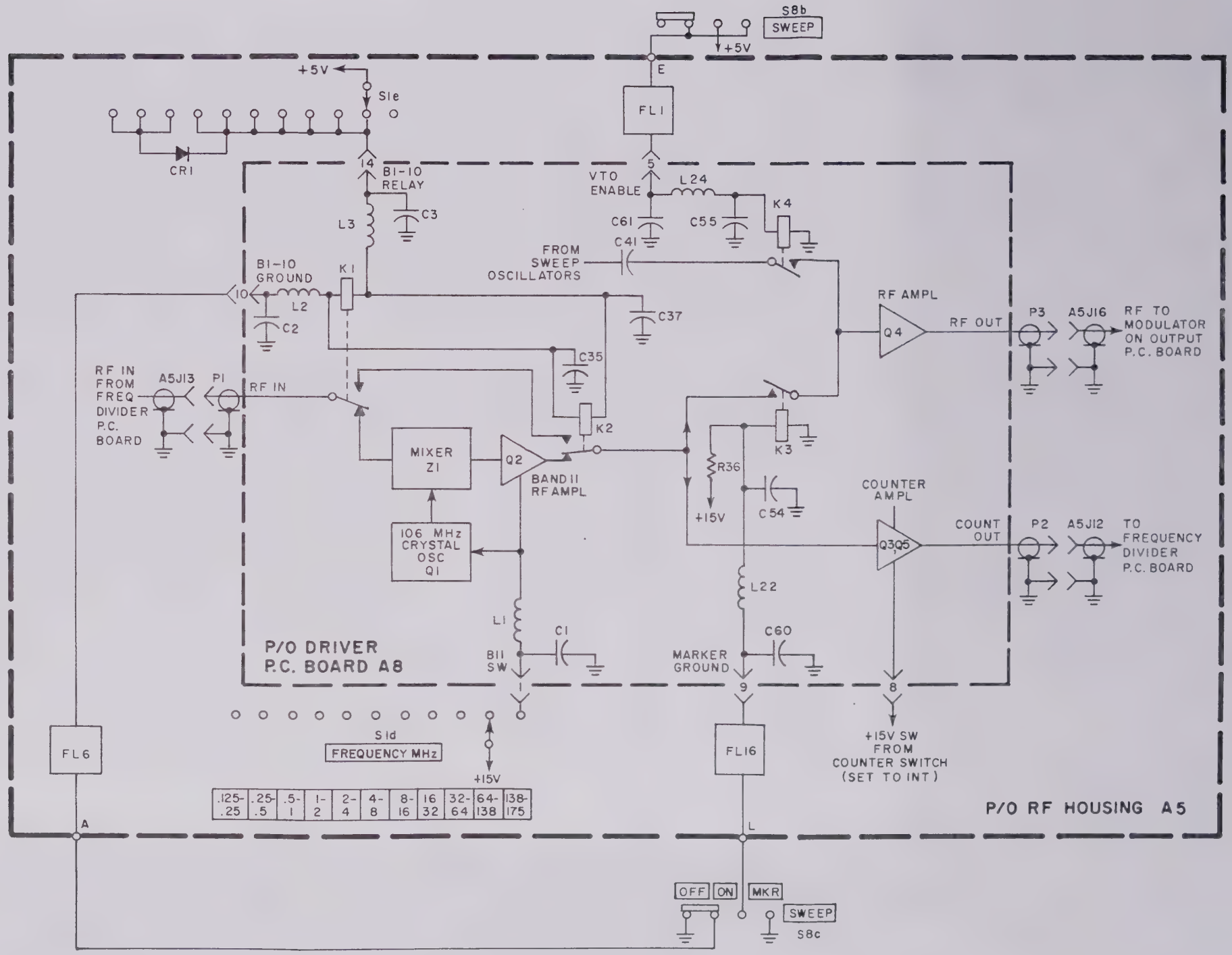


Figure 3-6. Driver Printed Circuit Board A8, RF Signal Processing Circuits, Detailed Block Diagram

is applied through contacts of relay A13K2 to the frequency-counter circuits to provide a display of the marker-signal frequency.

3-54. DETAILED THEORY OF OPERATION, INTENSITY MARKER CIRCUITS.

(See figure 3-7.)

3-55. The intensity marker circuits are used to generate an intensity marker pulse at the point where the frequency of the frequency swept signal corresponds to that of a marker frequency signal selected by means of the TUNING control. The intensity marker signal is available at the rear panel INTENSITY MARKER OUT connector for Z-axis modulation of an oscilloscope. It serves as an aid in determining the frequency at pertinent points of the response pattern on the oscilloscope when using the swept frequency mode of operation. The intensity marker circuits function only for 10.7 MHz and 98 MHz frequency sweep signals.

3-56. The sweep frequency from the marker output on driver printed circuit board A8 is supplied to the contact of relay K1, which is controlled by demultiplexer IC1. If SWEEP switch S8c is set to the MKR position and FREQUENCY MHz switch A5S1b is set to either band 7 or band 10, demultiplexer IC1 energizes relay K1 through relay driver Q2, and the sweep frequency signal is applied through buffer Q1 to one input of mixer Z1. The marker frequency from frequency divider printed circuit board A13 is supplied to the second input of the mixer; this marker frequency is adjustable by means of the front panel TUNING control and the frequency is indicated on the output frequency indicator. The two signals are heterodyned by mixer Z1, and the mixer output is amplified by amplifier A1 and rectified by detector CR2-CR3. As the sweep frequency approaches frequency coincidence with the marker frequency, the output of mixer Z1 rises abruptly, and the DC output of the detector rises proportionally. The output of the detector is compared with a preset reference voltage by comparator A2. The preset reference voltage is supplied through demultiplexer IC2, and is determined by the selected frequency band and deviation; potentiometers R21, R23, and R27 provide means for adjusting the reference voltage for the three usable sweep frequency range and deviation combinations. When the output voltage from the detector exceeds the selected reference voltage, comparator A2 triggers delay multivibrator IC4, and the output pulse of the delay multivibrator triggers output multivibrator IC5, which generates a narrow, positive-going pulse that is available at INTENSITY MARKER OUT connector A5J10. Delay multivibrator IC4 can be adjusted for each of the usable sweep frequency range and deviation combinations by means of potentiometers R28, R30, and R31. Selection of the appropriate potentiometer is accomplished by demultiplexer IC3 based on the settings of the FREQUENCY MHz and DEVIATION kHz switches.

3-57. DETAILED THEORY OF OPERATION, OUTPUT CIRCUITS.

(See figure 3-8.)

3-58. The output circuits of the signal generator provide amplitude modulation, automatic leveling, filtering, wideband amplification, and output level adjusting and metering capabilities. Input RF signals are supplied from the driver printed-circuit board in the output-frequency selection circuits.

3-59. Input RF is applied to a diode modulator, which is controlled by differential amplifier A7A1. The diode modulator performs two functions: automatic leveling and amplitude modulation. The diode modulator consists of series-connected silicon diodes, in a balanced configuration, whose effective impedance is determined by the magnitude of a control voltage supplied by differential amplifier A7A1. The amplitude of the RF output signal varies in accordance with the attenuation provided by the modulator.

3-60. For automatic leveling operations, a DC level determined by the setting of the OUTPUT control is applied to one input of differential amplifier A7A1. The second input to the differential amplifier is an AGC signal derived through detection of the RF output signal of the instrument and having a magnitude proportional to the RF output signal amplitude. As long as the RF output signal amplitude of the instrument corresponds to the level selected by means of the OUTPUT control, the AGC signal remains constant, and the diode modulator presents a constant attenuation to the RF signal to maintain the selected RF output level. If the output level of the instrument tends to deviate from that established by the OUTPUT control setting, the AGC signal fed back to differential amplifier A7A1 changes, and amplifier A7A1 changes the effective attenuation of the diode modulator by such an amount as to compensate for the change in the RF output level. The AGC loop maintains the output level of the instrument within ±0.5 dB of a nominal value regardless of frequency changes within a particular band.

NOTE

If the RF switch is set to the OFF position, -5.2 volts DC is disconnected from the frequency divider circuits, resulting in a minimal level of RF output.

3-61. For AM operation, the modulating signal voltage is superimposed on the DC level applied from the OUTPUT control. The output of differential amplifier A7A1 is, therefore, a signal that follows the modulating signal. The attenuation of the diode modulator varies in accordance with the modulating signal, and the output of the diode modulator is an amplitude modulated RF signal. When this amplitude modulated signal is detected, a modulating signal component is present in the AGC feedback along with a DC component, and negative feedback at the modulating signal frequency occurs. This negative feedback improves the linearity of AM, especially at low modulating signal frequencies where the loop gain is high. The AM bandwidth is controlled by frequency selective networks at the output of differential amplifier A7A1 and the detector. When the FREQUENCY MHz switch is set to any of the three lowest bands, relays A7K1 and A7K2 are energized through switch section A5S1e to change time constants in a manner to narrow the bandwidth of the loop.

3-62. Low-frequency and high-frequency filters attenuate harmonics. Because of the relatively wide tuning range, two filters are used on each band. Routing of the RF signal to the appropriate filter bank is accomplished by relay A9K1. Selection of the proper individual filter is accomplished by means of FREQUENCY MHz switch section A5S1f. Each filter has a PIN diode at its input and another PIN diode at its output. Switch section A5S1f supplies +15 volts DC. Cam-operated switch S11 supplies +5 volts DC to relay A9K1 at the high end of each band, forward biasing the diode switches in the proper individual filter, and the RF signal is routed through the appropriate high-frequency filter for the selected band. At the low end of each band, this voltage is turned off and relay A9K1 is deenergized, thereby routing the RF signal through the appropriate low-frequency filter for the selected band.

3-63. For sweep frequency operation, separate sweep oscillators generate the RF signal, and the TUNING control is used only for the marker function. To ensure selection of the proper filter section for sweep operation when SWEEP switch S8 is set to the ON or MKR position, +5 volts DC is applied through switch section S8b to energize relay A9K1 thereby selecting the high-frequency filter section in all cases.

3-64. The filtered RF signal from the high-frequency or low-frequency filter is applied to a wide-band RF amplifier. The RF signal is amplified by the wide-band amplifier, and is then supplied to the OUTPUT LEVEL attenuator. The RF output of the wide-band RF amplifier is also applied to diode demodulator A7CR9. In addition to the leveling function previously described, the diode demodulator supplies DC, which is proportional to the RF signal level, through amplifier A7A2 to the OUTPUT LEVEL meter circuits to provide a direct indication of the output level of the signal generator. The scale of the OUTPUT LEVEL meter is calibrated to indicate both dBm and voltage levels for a 50-ohm load. Potentiometer A3R23 provides a means for electrical zeroing of the OUTPUT LEVEL meter, and potentiometer A3R20 is used to calibrate the meter. Scaling resistor A1R44 is connected into the meter circuit to provide proper scaling when RF switch A1S12 is set to the 3V position. The modulating signal component developed by diode demodulator A7CR9 is applied through amplifiers A7A2 and A7A3 to the rear panel DEMOD AM connector.

3-65. The RF output signal is applied to the front panel OUTPUT connector through the OUTPUT LEVEL attenuator. An RF fuse option is available to protect against damage which might be caused by excessive power from external sources. The OUTPUT LEVEL attenuator is a precision attenuator, providing output levels of -120 dBm to +10 dBm in 10 dB steps. The OUTPUT control discussed in paragraph 3-60 provides a means for further adjustment of the output level between 10 dB steps. Using the OUTPUT LEVEL attenuator and the OUTPUT control, the output level of the signal generator can be adjusted to any value within the range of -130 dBm to +13 dBm (0.07 microvolt to 1 volt into 50 ohms). When the RF switch is set to the 3V position, the output range is increased by 10 dB.

3-66. DETAILED THEORY OF OPERATION, MODULATION CIRCUITS.

(See figure 3-9.)

3-67. **General.** The modulation circuits provide the modulating signals required for amplitude modulation; frequency modulation, and sweep frequency of the output RF of the signal generator. The modulation circuits include a modulation oscillator, which provides an internal modulating signal, and a function generator, which provides a 50-60 Hz, line synchronized ramp voltage for frequency sweep operation. FM is accomplished in the signal generator through use of the varactors in the VFO resonant circuit, AM is accomplished through use of the diode modulator in the output circuits, and sweep frequency is accomplished through use of varactors in the resonant circuits of the sweep oscillators.

3-68. **Internal FM.** When the FM INT switch is depressed, the output signal of the signal generator can be frequency modulated using the internal modulation oscillator as the modulating signal source. Simultaneous AM is also possible. Modulation oscillator A41A6 uses a Wein-bridge circuit to generate the modulating signals. The frequency of oscillation is determined by a resistance-capacitance network connected

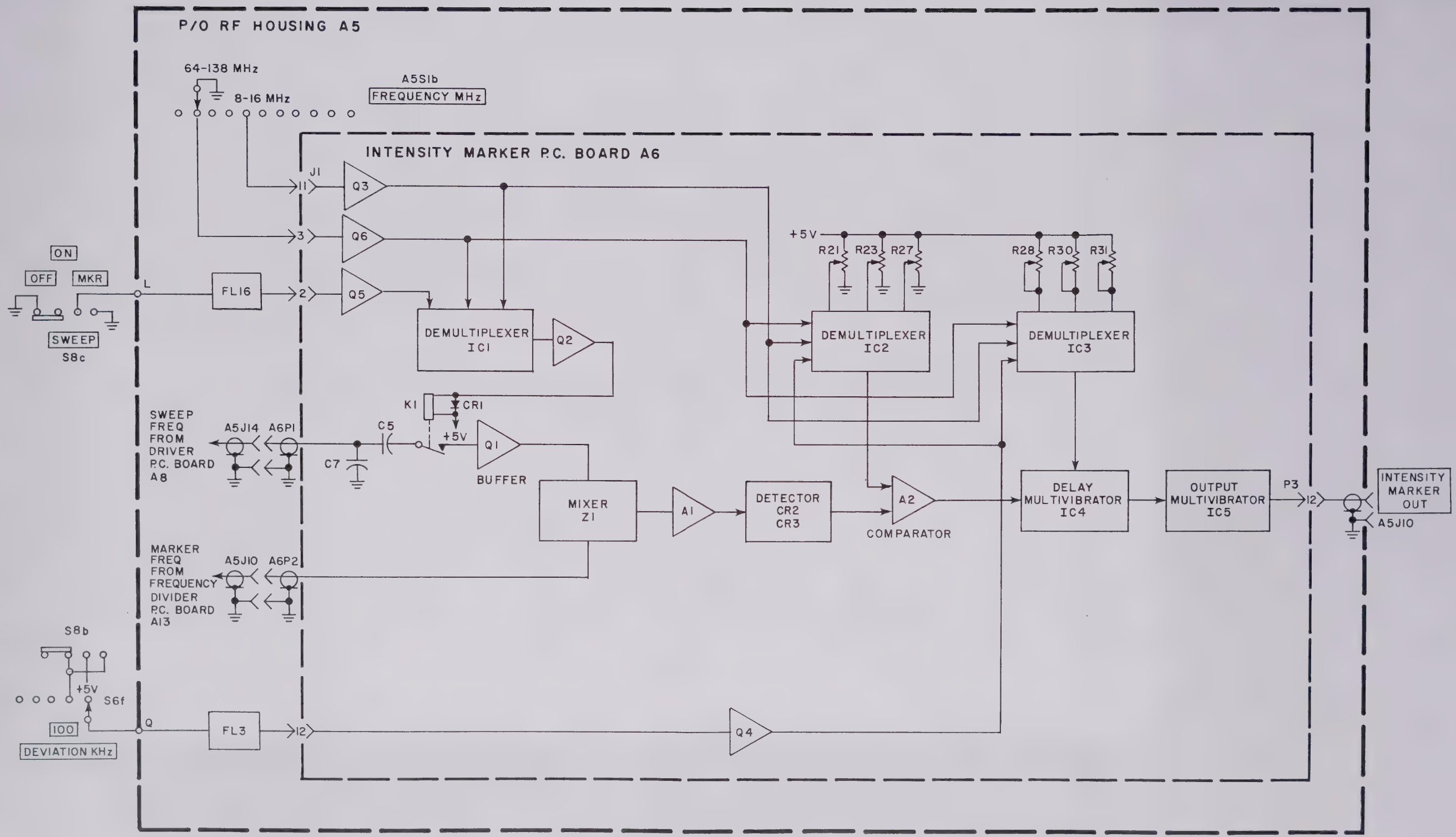


Figure 3-7. Intensity Marker Printed Circuit Board A6, Detailed Block Diagram

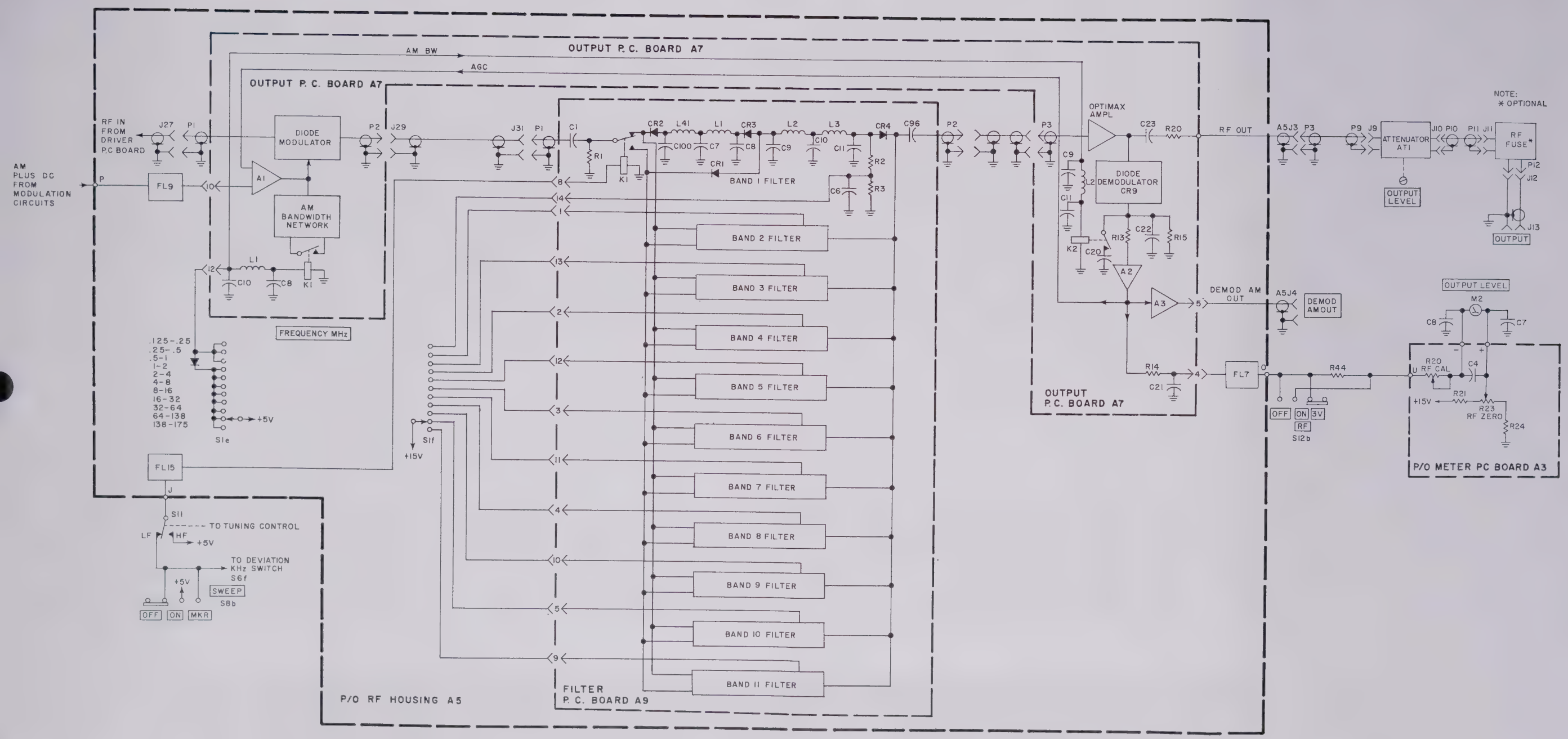


Figure 3-8. Output Circuits, Detailed Block Diagram

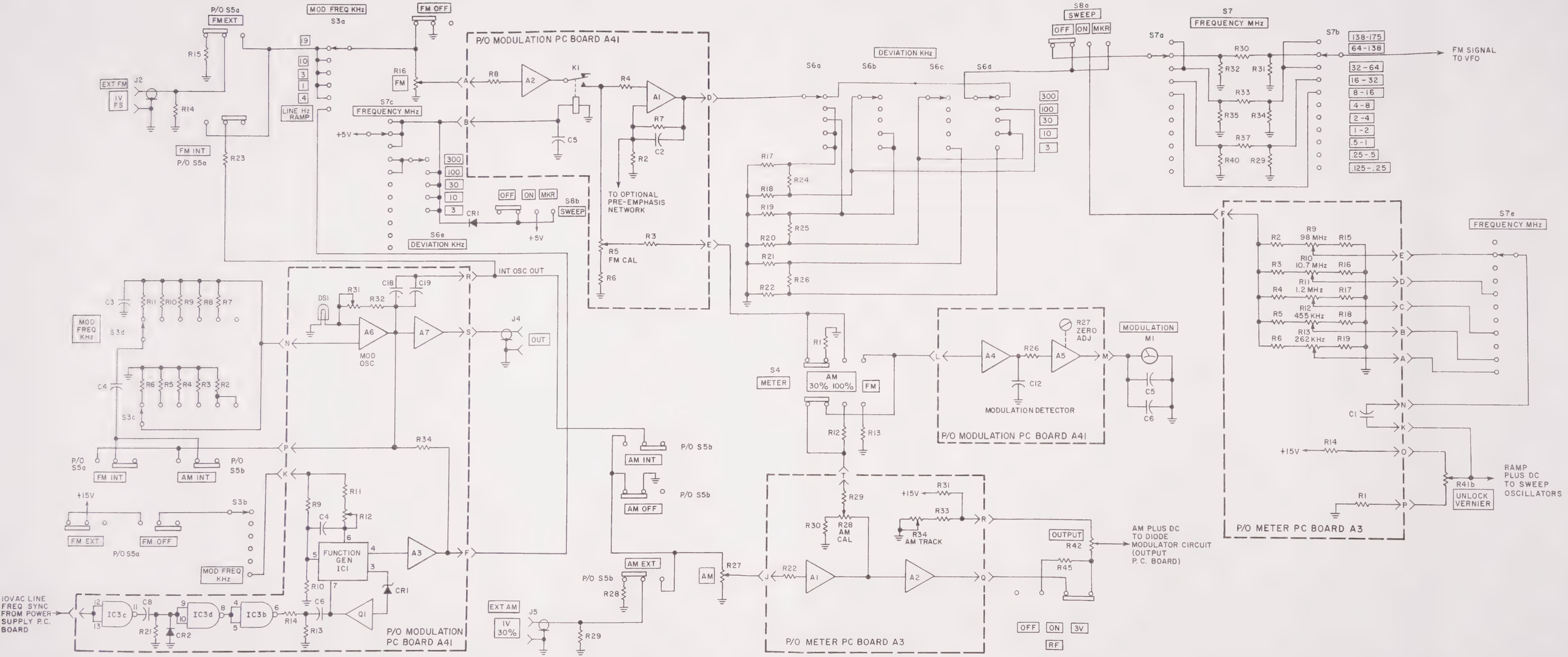


Figure 3-9. Modulation Circuits, Detailed Block Diagram

into the modulation oscillator circuit by MOD FREQ kHz switch sections S3c and S3d. Any one of five internal modulation frequencies may be selected: 0.4 kHz, 1 kHz, 3 kHz, 10 kHz, or 19 kHz. Amplifier A41A7 supplies an isolated modulating signal output to the front panel OUT connector for synchronization of external equipment.

NOTE

When the MOD FREQ kHz switch is set to the LINE Hz RAMP position, modulation oscillator A41A6 is inactive because the feedback network is opened at switch A1S3d.

3-69. The internally generated modulating signal is applied through resistor A1R23, a second section of the FM INT switch, and MOD FREQ kHz switch section S3a (all positions except LINE Hz RAMP) to the FM modulation circuits. FM control R16 provides a means for adjusting the amplitude of the modulating signal (and thus the FM deviation). The modulating signal output from the FM control is applied to amplifier A41A2, whose output is controlled by relay A41K1. Relay A41K1 is controlled through FREQUENCY MHz switch section A1S7c, DEVIATION kHz switch section A1S6e, and SWEEP switch section S8b. On the three highest bands, relay A41K1 is energized directly through switch section A1S7c. On bands 7 and 8, where maximum deviation is limited to 100 kHz, relay A41K1 is energized through switch sections A1S7c and A1S6e when the latter switch is set to one of the permissible deviation settings. SWEEP switch section S8b is used to control relay operation for the sweep mode of operation, and is set to the OFF position for the FM mode of operation. When relay A41K1 is energized, the output modulating signal from amplifier A41A2 is applied to the metering circuits and to amplifier A41A1. Option-13 provides a pre-emphasis network which shapes the frequency response of amplifier A41A1 to match the standard 75μs curve.

3-70. The maximum calibrated deviation of the instrument is determined by the setting of DEVIATION kHz switch sections A1S6a through A1S6d, which insert appropriate constant-impedance resistive attenuation networks into the modulating signal path. A second series of constant-impedance resistive attenuation networks is controlled by FREQUENCY MHz switch sections A1S7a and A1S7b. Frequency division of a frequency modulated signal, as occurs in this instrument, results in a corresponding division of the FM deviation. The resistive attenuation networks inserted into the FM modulating signal path by the FREQUENCY MHz switch sections adjust the modulating signal amplitude to maintain the selected maximum deviation regardless of band selection. The same attenuation network is used for bands 11 and 9 because the band 11 output frequency is derived from the band 9 frequency through a mixing process that does not affect deviation. The FM modulating signal is applied to the varactor circuit in the VFO to produce frequency modulation of the VFO output signal.

3-71. The actual deviation in FM applications is determined by the setting of the DEVIATION kHz switch and the FM control. Because deviation is proportional to the amplitude of the modulating signal, an indirect indication of deviation can be obtained by measuring the modulating signal amplitude. A portion of the FM modulating signal is applied through FM CAL potentiometer A41R5 and METER switch S4 (FM position) to modulation detector A41A4-A41A5, and the modulation detector DC output is applied to the front panel MODULATION meter to provide an indication of the actual deviation. (The meter scale is calibrated to indicate deviation directly.) A41A4-A41A5 function as a positive peak detector.

3-72. Simultaneous AM, using an external modulating signal source, may be used with internal FM. Operation in this manner is described in paragraph 3-74.

3-73. External FM. The FM EXT switch is depressed for frequency modulation of the signal generator output by an external modulating signal. In addition, it is required that the MOD FREQ KHz switch not be in the LINE Hz RAMP position. The mechanically interlocked FM INT switch sections are now set to their normally off positions, thereby turning of the internal modulation-oscillator and disconnecting the internal modulation-oscillator output from the frequency modulation circuits. An external signal applied through front panel 1V FS connector J2 is then applied through the FM EXT switch section to the frequency modulation circuits in place of the signal from the internal modulation oscillator. Except for this change in the modulating signal source, the frequency modulation circuits operate in the same manner as for the internal FM mode of operation. Simultaneous AM, using either the internal modulation oscillator or an external modulating signal source, is possible. (If internal AM is selected, the internal modulation-oscillator is turned on through the AM INT switch; the internal modulation-oscillator output is applied to the AM circuits, but is disconnected from the FM circuits by the disengagement of the FM INT switch.)

3-74. Internal AM. When the AM INT switch is depressed, the output signal of the signal generator can be amplitude modulated using the internally generated modulating signal. Simultaneous FM, using the internal, or an external modulating signal is possible. Modulation oscillator A41A6 is connected to its frequency determining network through one section of the AM INT switch, and the modulation oscillator and amplifier operation is the same as described in paragraph 3-68.

3-75. The internally generated modulating signal is applied through the second section of the AM INT switch to AM control A1R27, which provides a means for adjusting the amplitude of the modulating signal and thus the percentage of AM. The modulating signal is applied through amplifiers A3A1 and A3A2 to the OUTPUT control circuits. The output voltage at the arm of the OUTPUT control consists of a DC level, which establishes the output level of the signal generator, and a modulating signal component that produces the AM. Both the DC and AM modulating signal components vary as the OUTPUT control is adjusted; therefore, the percentage of AM remains constant as the output level is varied. RF switch A1S12 provides a means for selecting either the normal output range of the signal generator or a high-level output. For normal AM operations (both internal and external), RF switch A1S12 is set to the ON position, and resistor A1R45 is inserted in series with the OUTPUT control, thereby reducing the DC level supplied to the diode modulator in the output circuits so as to establish the normal output level. When switch A1S12 is set to the 3V position, resistor A1R45 is shorted by one switch section, and a higher DC voltage level is developed at the output of the OUTPUT control. This higher DC level produces a higher output level for the instrument through the diode modulator in the output circuits. When the RF switch is set to the OFF position, the OUTPUT control is grounded through resistor A1R45 and -5.2 volts DC is applied to the frequency divider printed-circuit board to turn off the frequency divider circuits, thereby significantly reducing the output RF signal from the signal generator.

3-76. A portion of the AM modulating signal is applied from amplifier A3A1 through AM CAL potentiometer A3R28 and METER switch A1S4 (30% AM or 100% AM position) to the metering circuit to provide an indication of the percentage of AM. Two meter ranges are provided for AM: 0 to 30%, and 0 to 100%. An appropriate scaling resistor (A1R12) is inserted into the metering circuit by switch A1S4 when the switch is set to the 100% AM position. The AM modulating signal is detected by modulation detector A41A4-A41A5 which drives the front panel MODULATION meter, calibrated to indicate percentage of AM directly.

3-77. Simultaneous FM, using the internal, or an external modulating signal source, can be used with internal AM. Operation of the FM modulation circuits using an external modulating signal source is described in paragraph 3-73.

3-78. **External AM.** The front panel AM EXT switch is depressed to select the external AM mode of operation. Pressing this switch causes the frequency-determining network to be disconnected from the internal modulation oscillator by one section of the interlocked AM INT switch, the modulation oscillator output circuit to be disconnected from the AM modulation circuits, and an external modulating signal applied through front panel 1V 30% connector J5 to be applied to the AM modulation circuits. Except for the change in the modulating signal source, the AM modulation circuits function exactly as described in paragraphs 3-74 through 3-77. Simultaneous FM, using an internally generated or an externally supplied modulating signal, is possible.

3-79. **Frequency Sweep.** For the frequency sweep mode of operation using the internally generated ramp voltage, the AM OFF and FM INT switches are depressed, the SWEEP switch is set to the ON or MKR position, and the MOD FREQ kHz switch is set to the LINE Hz RAMP position. The AM OFF switch grounds the input to the AM modulation circuits, thereby preventing AM operation. With the FM INT switch actuated, +15 volt DC is applied through the FM function switch sections and the LINE Hz RAMP position of switch section S3b to function generator A41IC2. Function generator A41IC2, with limiter A41Q1 produces a stable line frequency ramp voltage. Potentiometer A41R12 provides means for adjustment of the ramp frequency. The line frequency ramp signal is applied through amplifier A41A3 and MOD FREQ kHz switch section S3d (in the LINE Hz RAMP position only) to the FM modulation circuits. The ramp signal is also coupled through emitter follower A41A7 to the front panel OUT connector for synchronization of external equipment.

3-80. The line frequency ramp signal is processed by amplifiers A41A2 and A41A3 in the same manner as the FM modulating signal. FM control A1R16 provides a means for adjusting the ramp signal amplitude. Relay A41K1 is energized through diode A1CR1 and SWEEP switch section A1S8b. The line frequency ramp signal at the output of amplifier A41A1 is applied through the DEVIATION kHz switch (sections A1S6a through A1S6d) which is usually set to the 300 position for frequency sweep operation, and SWEEP switch section A1S8a to resistive networks that provide means for sweep calibration on each of the five sweep bands of the instrument. The ramp voltage from the appropriate network is selected by means of FREQUENCY MHz switch A1S7e, and is coupled through capacitor A3C1 to the front-panel unlock VERNIER control circuit. A DC voltage is also supplied to the unlock VERNIER control, and the combined DC and ramp voltages are supplied to a varactor in the selected sweep oscillator circuit. The DC level establishes the center frequency of the active sweep oscillator, and the ramp signal varies the frequency in an essentially linear manner about this center. The DEVIATION kHz control is functional in this mode and may be used for reduced deviation settings in 10 dB steps as in the normal FM mode.

3-81. Sweep frequency operation can also be achieved using an external ramp voltage signal source. For such operation, the external signal source is connected to the front panel 1V FS connector, the FM EXT switch is depressed, and the MOD FREQ kHz switch is set to any position other than the LINE Hz RAMP position. The ramp voltage from the external source is then processed by the modulation circuits in the same manner as the internally generated ramp voltage, and the ramp voltage from the external source modulates the active sweep oscillator.

3-82. CW. To select the CW mode of operation, the FM OFF and AM OFF switches are both depressed. The FM OFF switch grounds the input to the FM modulation circuits, and the AM OFF switch grounds the input to the AM modulation circuits; therefore, AM, FM, and sweep frequency operation are not possible. The amplitude of the RF output signal from the instrument remains constant at the level established by the settings of the OUTPUT LEVEL attenuator and the OUTPUT control.

3-83. DETAILED THEORY OF OPERATION, FREQUENCY COUNTER CIRCUITS.

(See figure 3-10.)

3-84. The frequency counter circuits may be used to provide a continuous display of the output frequency of the signal generator, or to measure the frequency of any external signal in the range of 5 Hz to 175 MHz. The elimination of a tuning dial, made possible through use of the frequency counter circuits, eliminates one major source of operator error and recalibration problems. A six digit LED with selectable resolution is used for the indication of output frequency. The output frequency is displayed in a clear, unambiguous manner, simplifying tuning and enhancing resettability.

3-85. For display of the RF output frequency of the signal generator, COUNTER switch S9 is set to the INT position. One section of the switch supplies +15 volt DC to activate the counter amplifier on the driver printed circuit board in the output-frequency selection circuits. The selected RF signal is then routed through the counter amplifier, and is applied through contacts of relay A10K1 to amplifiers A10Q1-A10Q2. A diode limiter at the input of amplifier A10Q1 limits input signal amplitude to acceptable levels. The RF signal is further amplified and shaped by stages A10IC1a through A10IC1c, and a series of gates determines RF signal routing from this point. If the FREQUENCY MHz switch is set to any of its four highest bands, or if the RESOLUTION Hz switch is set to any position other than the 1 position, gate A10IC2e is activated by a logic low (ground) supplied through the switches, and the RF signal is applied to divider A10IC4-A10IC6, which divides the applied frequency by 10. The logic low supplied by the switches is also applied to gate A10IC2c, which provides both an inverted (high) and non-inverted (low) output. The high output deactivates gate A10IC2a, preventing transfer of the RF signal directly from amplifier A10IC12c to the output. The low output of gate A10IC2c activates gate A10IC2b, and the frequency-divided RF is routed from divider A10IC4-A10IC6 through gate A10IC2b to the output. If the RESOLUTION Hz switch is set to the 1 position (for output frequencies below 16 MHz only), a logic high is supplied to gates A10IC2e and A10IC2c from the switch circuits. The logic high deactivates gate A10IC2b, preventing transfer of the RF signal to the divider. Instead, the RF signal is routed directly from the output of amplifier A10IC1c through gate A10IC2a to the output.

3-86. Positioning of the decimal point in the frequency display is controlled through gates A16IC6a and A16IC3a, and the RESOLUTION Hz switch. If the RESOLUTION Hz switch is set to the 1 position (and the FREQUENCY MHz switch is set to any band below 16 MHz), +5 volt DC is applied to both inputs of gate A16IC6a, and the resulting low output of gate A16ICa activates the decimal point in front of the first digit of the LED display. If a frequency range above 16 MHz is selected with a 1Hz resolution, gate A16IC4a is activated at a 1 Hz rate by decade counter A16IC12, and the 1 Hz output of gate A16IC4a flashes the front panel 16 MHz MAX indicator through inverter A16IC1c to alert the operator that the input signal frequency should be limited to a maximum of 16 MHz for 1 Hz resolution. In this position the prescaler and 10 Hz decimal point are also automatically enabled. When a 10 Hz resolution is selected, the logic input to terminal 13 of gate A16IC6a changes from a high to a low, thereby deactivating the first position decimal point function. This low is inverted by inverter A16IC1b, gate A16IC3a is activated, and the low output of gate A16IC3a activates the decimal point in front of the second digit of the LED display, effectively shifting the decimal point one digit to the right. The decimal point is similarly shifted one position to the right through RESOLUTION Hz switch section A1S10c each time the switch is advanced one position beyond the 10 position. (Gate A16IC3a is deactivated through switch section A1S10b in the 100 and 1K positions of the switch.)

3-87. For measurement of the frequency of an external signal, the COUNTER switch is set to the EXT position and the external signal is connected to EXT COUNTER connector J7. One COUNTER switch section applies a ground to relays A11K1 and A11K2, energizing relay A11K1 and deenergizing relay A11K2. Relay A11K2 disconnects DC power from the counter amplifier on the driver printed circuit board, thereby disconnecting the internal RF signal from the frequency counter input circuits. Relay A11K1

connects the external signal to the input of amplifier A11Q1. The external signal is processed from this point in the same manner as the internal signal.

3-88. To measure the frequency of the processed internal or external signal, the sequence of events involved in each measurement step is as follows:

a. A gate pulse of suitable duration is generated.

b. The number of input signal pulses applied during the gate pulse interval is counted and stored by six decade counters.

c. After the gate pulse has been terminated, a strobe pulse is applied to the LED displays, and the count stored by each of the associated decade counters is displayed and stored by the corresponding LED display.

d. A reset pulse is then generated, and the decade counters are reset for the next cycle of operation.

3-89. Crystal oscillator A16Y1 provides a stable 1 MHz frequency which establishes the timing of the gate, strobe, and reset pulses. The crystal oscillator is a temperature-compensated type with a low aging rate, and may be reset as necessary. The 1 MHz frequency is divided by four, five, or six decade counters, depending upon the setting of the RESOLUTION Hz switch. The gate time corresponds to the period (1/f) of the output of the last decade counter employed. For resolutions of 1 Hz and 10 Hz, the output of decade counter A16IC12 is applied through gates A16IC6b and A16IC4c to the clock input of flip-flop A16IC9, and the flip-flop is switched on and off alternately to develop a gate pulse of 1 second duration. For 100 Hz resolution, the output of counter A16IC10 is applied through gates A16IC6c and A16IC4c to the flip-flop, and the flip-flop is switched on and off to produce a gate pulse of 0.1 second. For a resolution of 1 kHz, the flip-flop is switched on and off by the output of decade counter A16IC8 to produce a gate pulse of .01 second. During the gate period, the Q output of flip-flop A16IC9 is at a logic 1 level, gate A2Q2 enables amplifier A2Q1, and decade counters A2IC1 through A2IC6 are toggled according to the number of incoming pulses supplied through amplifier A2Q1.

3-90. When flip-flop A16IC9 is next triggered, it reverses its state, thereby terminating the gate pulse. The Q output drops and the Q output switches to a logic 1 level. At this time, gate A2Q2 inhibits operation of amplifier A2Q1, and no additional count of frequency pulses occurs. During this period, a logic 1 level clock pulse is developed at terminal 8 of the last active decade counter, and this logic 1 level activates the strobe section of dual driver A16IC11 through gates A16IC4b and A16IC3b, A16IC3c, or A16IC3c, as determined by the setting of the RESOLUTION Hz switch. The Q output of flip-flop A16IC9 being high, dual driver A16IC11 develops a strobe signal which is applied through strobe amplifier A16Q1 to LED displays A2DS1 through A2DS6, and the LED's store and display the count registered in the corresponding decade counters.

3-91. As the pulse at terminal 8 of the last active decade counter (A16IC8, A16IC10, or A16IC12) is terminated, an output pulse is generated at terminal 11. This output pulse is applied to the clock input of flip-flop A16IC9 and to the reset portion of dual driver A16IC11. Since both inputs to the reset section of the dual driver are at a logic 1 level, a reset pulse is developed by the dual driver. This reset pulse is applied to decade counters A2IC1 through A2IC6, resetting their count to zero. As soon as flip-flop A16IC9 changes its state, the reset pulse is terminated, the Q output of flip-flop A16IC9 switches to a logic 1 level, and the next counting cycle begins.

3-92. DETAILED THEORY OF OPERATION, POWER SUPPLY CIRCUITS.

(See figures 6-1 and 6-15.)

3-93. The power supply circuits provide DC operating power for all other circuits of the signal generator. Regulated output voltages of +5, -5.2, +15, and -15 volts are provided. The power supply circuits are designed to operate from AC power sources of 100, 120, 220, or 240 volts, 50 to 400 Hz.

3-94. Input AC power is supplied to the primary windings of power transformer T1 (figure 6-1) through the AC power cord, line fuse, POWER switch A2, and line voltage selector switch S1. Switch S1 connects the 120 volt sections of the transformer primary in series for 240 volt operation, and in parallel for 120 volt operation. A 20 volt primary section can also be switched into the input power circuit to accomodate the changes in input line voltage from 120 to 100 volts, and from 240 to 220 volts. The line fuse protects the power supply circuits against overload. The AC voltages developed in the four secondary windings of power transformer T1 are applied to four bridge rectifier circuits on power supply board A14 (figure 6-15).

3-95. The 18 volt AC voltage of one secondary winding of power transformer T1 is rectified by bridge rectifier A14CR1. The resulting DC is filtered and then regulated by voltage regulator A14IC1 and error amplifier A14A1. The error amplifier continuously samples the output voltage of the power supply and supplies an error voltage to voltage regulator A14IC1, should any variation in output voltage occur. The effective impedance of regulator A14IC1 is thereby varied to compensate automatically for the output

voltage variations. Potentiometer A14R8 provides means for adjusting the regulated +15 volt DC output of this supply. A similar configuration is used to develop the regulated -15 volt DC; however, this power supply is slaved to the +15 volt DC supply, and no adjustment potentiometer is provided.

3-96. Two 10 volt secondary windings of power transformer T1 power the +5 and -5.2 volt DC supplies, which are similar. Each supply consists of a bridge rectifier, filter, and series regulator. No adjustment potentiometers are provided for these two supplies.

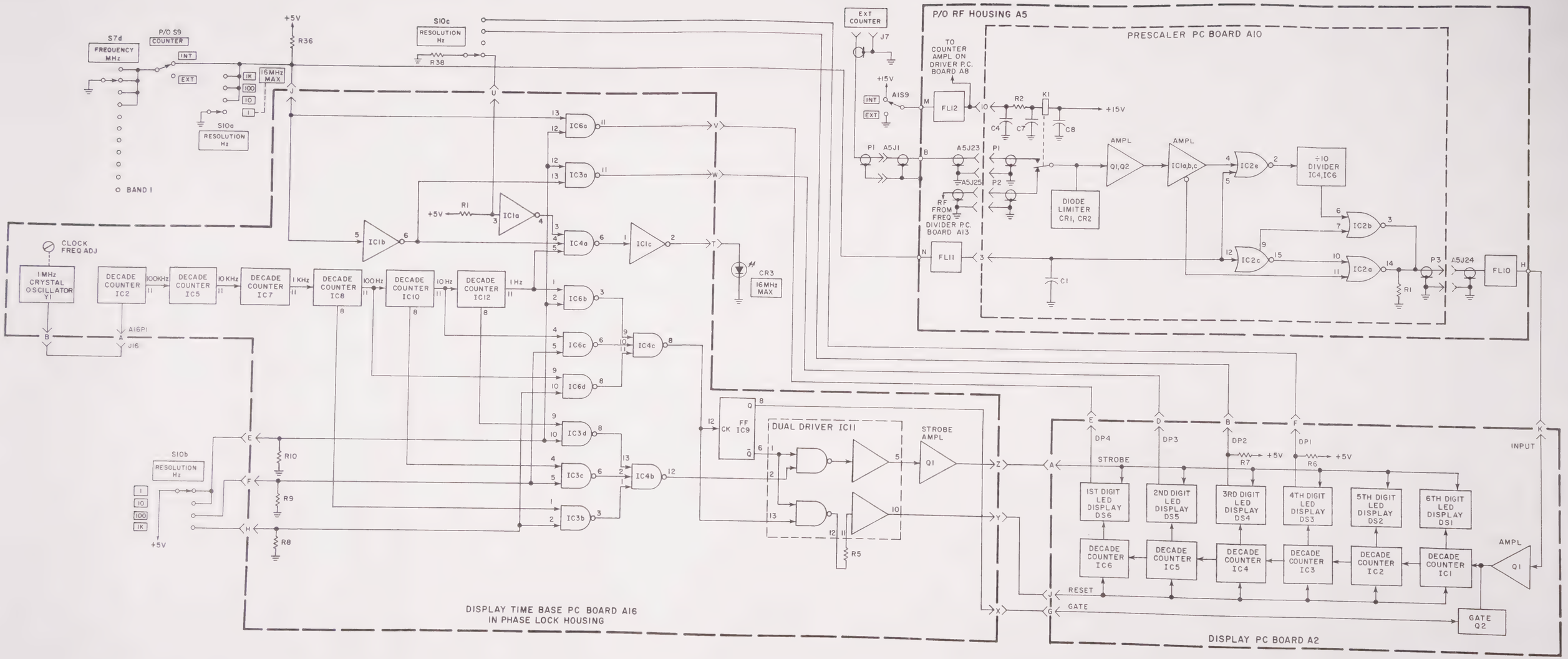


Figure 3-10. Frequency Counter Circuits, Detailed Block Diagram

SECTION IV
MAINTENANCE

4-1. GENERAL.

4-2. This section contains maintenance and calibration instructions for the signal generator. Included are a list of test equipment required for maintenance, symptomatic and systematic troubleshooting procedures designed to localize a malfunction to an individual subassembly or circuit, and alignment and adjustment instructions for restoring the signal generator to proper operating condition after repairs have been completed.

NOTE

For minimum performance tests of the signal generator refer to Section II of this manual.

4-3. TEST EQUIPMENT REQUIRED.

4-4. Test equipment required for maintenance is listed in Table 4-1. Equipment of equivalent characteristics may be substituted for any item listed.

4-5. PRELIMINARY INSPECTION.

4-6. **Visual Check.** If equipment malfunction occurs, perform a visual check of the signal generator before performing electrical tests. Visual checks often help to isolate the cause of the malfunction quickly and simply. Inspect the signal generator for signs of damage caused by excessive shock or vibration, such as: broken leadwires, loose hardware and parts, and loose electrical connections. Then check for signs of overheating which may be caused by electrical short circuits, or accumulation of dirt and other foreign matter. Correct any problems discovered through the visual check. If trouble persists, proceed with electrical checks.

4-7. **Power Supply Check.** Improper operation of the signal generator may be caused by incorrect DC operating voltages. Before proceeding with any other electrical checks, perform the power supply checks in accordance with Table 4-2.

WARNING

Line voltages up to 240 volts AC may be encountered in the power supply circuits. To protect against electrical shock, observe suitable precautions when connecting and disconnecting test equipment, and when making voltage measurements.

4-8. MAJOR ASSEMBLY LOCATION.

4-9. See figures 4-1 and 4-2 for the location of the major assemblies of the signal generator.

4-10. TROUBLE LOCALIZATION.

NOTE

Logical trouble localization involves three major procedures: symptomatic troubleshooting, used to localize the cause of a malfunction to a major circuit group; systematic troubleshooting within the affected circuit group, used to localize the cause of a malfunction to a circuit or stage; and voltage and/or waveform measurements, used to isolate the defective part.

4-11. **Symptomatic Troubleshooting.** The versatility built into the signal generator facilitates symptomatic troubleshooting. Various groups of circuits can be switched into or out of the operating chain through manipulation of the operating controls. Also, different circuit configurations are used for the various modes of operation. With a thorough understanding of the detailed block diagrams (figures 3-2 through 3-9), it is possible to localize the cause of most malfunctions to one of the major circuit groups by operating the controls and carefully observing the results of such operation. (Refer to Table 4-3.) When the cause of malfunction has been localized to a major circuit group, refer to the systematic troubleshooting chart for the affected circuit group.

TABLE 4-1. TEST EQUIPMENT LIST

Item No.	Nomenclature	Model No.
1	Voltmeter	Weston 1240
2	AC Voltmeter	Boonton Electronics Corp. 93A
3	Distortion Analyzer	Hewlett Packard 333A
4	Frequency Counter	Hewlett Packard 5300B/5303B/5311B, OPT 001
5	Modulation Meter	Boonton Electronics Corp. 82AD
6	Spectrum Analyzer	Hewlett Packard 140T/8552B/8554B
7	Audio Oscillator	Hewlett Packard 204C
8	Oscilloscope	Tektronix 5103N
9	RF Millivoltmeter	Boonton Electronics Corp. 92B
10	Probe	Boonton Electronics Corp. 91-12F
11	Probe Tip	Boonton Electronics Corp. 91-13B
12	Microwattmeter	Boonton Electronics Corp. 42B
13	Oscilloscope	Hewlett Packard 1740
14	Probe	Tektronix P6060-00
15	Extender Card	Boonton Electronics Corp. 92-6A

4-12. Systematic Troubleshooting. When the cause of an equipment malfunction has been localized to a major group of circuits, refer to the appropriate systematic troubleshooting chart (Tables 4-4 through 4-11). The systematic troubleshooting charts provide instructions for further localization of the cause of the malfunction to a stage or circuit within the major circuit group. When the cause of the malfunction has been localized to a particular stage or circuit, isolate the defective part using standard voltage and waveform measurement techniques. Refer to paragraph 4-36 for typical voltage data. Waveform data is included on the appropriate schematic diagrams. (See figures 6-1 through 6-22.)

NOTE

Unless otherwise indicated, all voltage values given in Tables 4-4 through 4-11 are nominal values; also, all voltages are measured with reference to ground.

4-13. Frequency Instability Problem Troubleshooting. If the signal generator exhibits instability symptoms, locate the cause of the trouble as follows:

a. Inspect the delrin clutch mechanism on the main tuning shaft. Verify that it is properly aligned and provides a moderate restraint on rotation of the main tuning shaft. If necessary, adjust the compression adjustment screw in the clutch mechanism to provide the proper restraint.

b. Visually check operation of the dial cord drive assembly throughout the entire range of rotation of the main tuning drive. If the dial cord appears to be trapped at any spot, restring the dial cord in accordance with the procedures of paragraph 4-27. Verify that the drum wheel does not operate in an eccentric manner. If it does, remove the drum wheel from the shaft, loosen the three screws in the boss, correct the alignment, tighten the screws, and replace the drum wheel on the shaft.

c. With the top cover of the VFO housing removed, push in an axial direction on the end of the main tuning shaft which enters the VFO housing. Verify that the shaft coupler is positioned properly. If it is not, loosen the setscrews in the shaft coupler, reposition the shaft coupler, and tighten the setscrews. Check to see that the ball bearing assembly in the VFO housing wall is secure, and that the inductuner is shimmed properly to provide moderate compression of the bowed, captivated washer on its shaft. The bearing assembly is attached to the VFO housing with epoxy glue.

d. With the bottom cover removed, rotate the TUNING control through its entire range. At every tuning point within the tuning range, the capacitor rotor plates must be

TABLE 4-2. POWER SUPPLY CHECK

Step	Procedure	Normal Indication
1	Set the signal generator POWER switch to the ON position. Using voltmeter, Weston Model 1240, measure the DC voltage, in sequence, between each of terminals A and B (+) and terminal C (-) of the power supply printed circuit board connector.	+15 ±0.1 volts DC
2	Using oscilloscope, Tektronix Model 5103N, measure the AC ripple voltage between terminals A and C of the power supply printed circuit board connector.	2 millivolts peak-to-peak or less
3	Using the voltmeter, measure the DC voltage, in sequence, between each of terminals D and E (-) and terminal C (+) of the power supply printed circuit board connector.	-15 ±0.15 volts DC
4	Using the oscilloscope, measure the AC ripple voltage between terminals D and C of the power supply printed circuit board connector.	2 millivolts peak-to-peak, or less
5	Using the voltmeter, measure the DC voltage between each of terminals H and I (+) and terminal G (-) of the power supply printed circuit board connector.	+5 ±0.2 VDC
6	Using the oscilloscope, measure the AC ripple voltage between terminals H and G of the power supply printed circuit board connector.	2 millivolts peak-to-peak or less
7	Using the voltmeter, measure the DC voltage between terminals F (-) and G (+) of the power supply printed circuit board connector.	-5.2 ±0.2 VDC
8	Using the oscilloscope, measure the AC ripple voltage between terminals F and G of the power supply printed circuit board connector.	2 millivolts peak-to-peak or less

approximately evenly spaced with respect to the stator plates; the absolute magnitude of the spacing between rotor and stator plates may vary from point to point. If the need for realignment of the capacitor plates is evident, loosen the rear bearing retaining nut on the variable capacitor, adjust the end stop of the capacitor as required, and tighten the retaining nut.

e. Inspect all VFO circuit components for damage. Correct any defects noted.

f. Tighten all mounting screws on the VFO board, variable capacitor, inductuner, and terminal strip. Check to see that the transistor heat sink and mounting clip are secure. The heat sink is soldered directly to the VFO board.

g. If the preceding steps do not cure the instability, check the dual wiper at the front of the variable capacitor for proper wiping action.

h. If output frequency instability persists, connect a 0.15 micro-henry inductor in place of the inductuner. If the instability problem disappears, clean and relubricate the inductuner as instructed in paragraph 4-33. If cleaning and lubrication of the inductuner is inconvenient or unsuccessful, replace the inductuner. Restore the original VFO circuit connections.

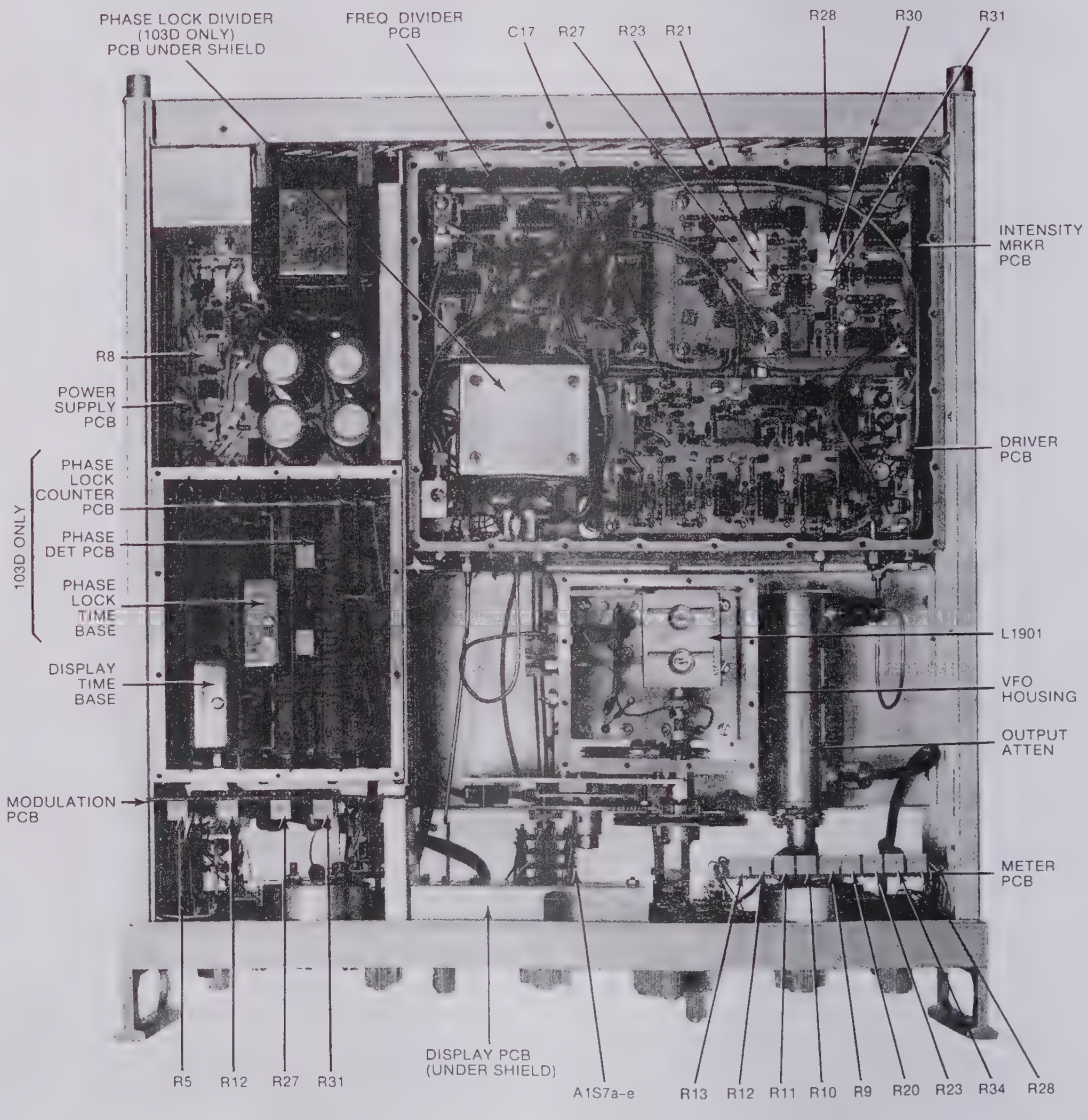


Figure 4-1 Signal Generator, Top View with Cover Shields Removed

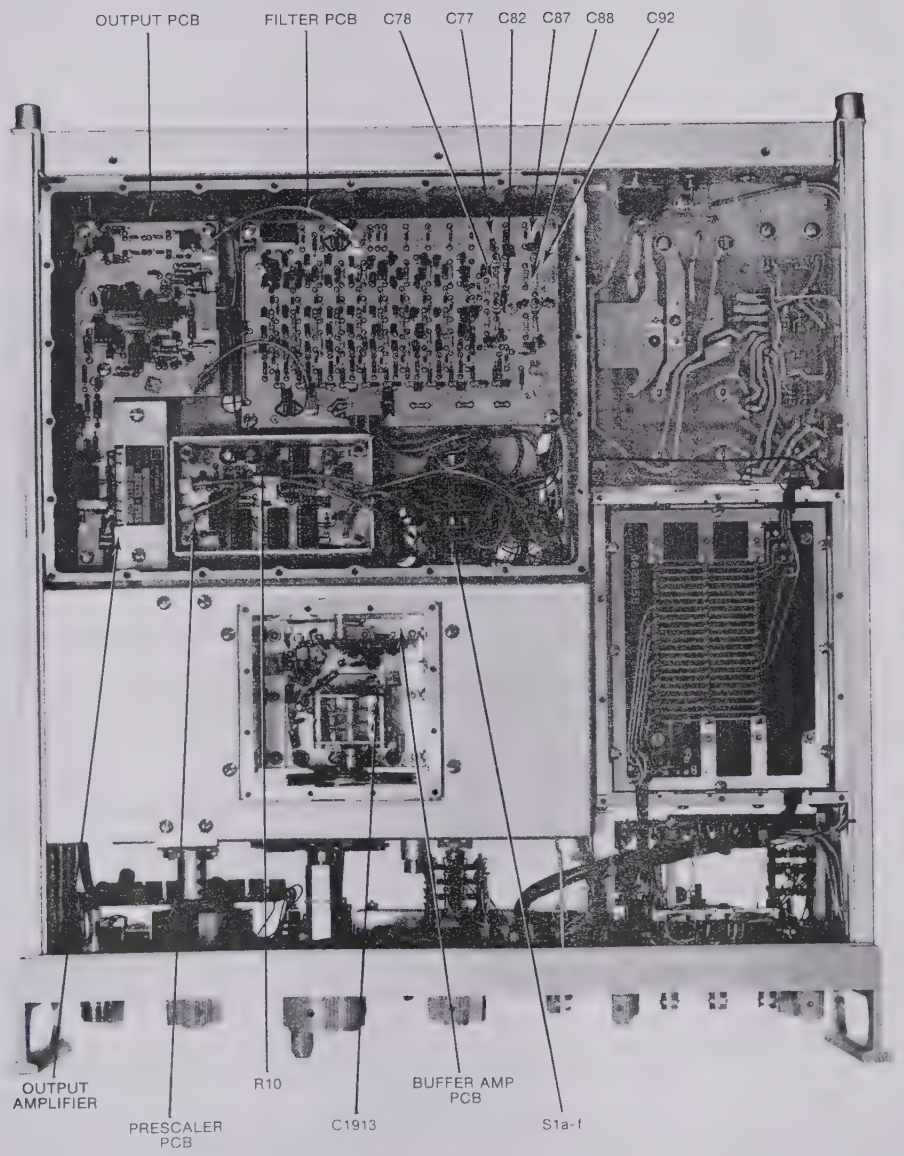


Figure 4-2 Signal Generator, Bottom View with Cover Shields Removed

TABLE 4-3. SYMPTOMATIC TROUBLESHOOTING CHART

Symptom	Probable Cause of Malfunction
No output on bands 1 through 11; output frequency indicator inoperative except during frequency sweep operation; frequency sweep operation normal except no marker signal is available.	Defective VFO circuits (Table 4-4); Defective output frequency selection circuits (Table 4-5).
No output or low output on lower bands; highest bands operate normally.	Defective output frequency selection circuits (Table 4-5).
No output on bands 1 through 11; no output for frequency sweep operation; output frequency indicator operates normally.	Defective output circuits (Table 4-8). Defective output frequency selection circuits (Table 4-5).
No output, or low output on band 11 only; operation normal otherwise.	Defective output frequency selection circuits (Table 4-5).
Operation normal on bands 1 through 11; no frequency sweep output available.	Defective output frequency selection circuits (Table 4-5). Defective modulation circuits (Table 4-7).
No output, or low output on only half of any or all bands; output frequency indicator operates normally.	Defective output circuits (Table 4-8).
Operation normal for band 1 through 11 output signals; one or more, but not all, frequency sweep signals unavailable.	Defective sweep oscillator circuits (Table 4-6).
Frequency sweep operation normal with external ramp signal; CW output is obtained when internal 50-60 Hz ramp is selected.	Defective modulation circuits (Table 4-7).
Operation normal except output frequency indicator is inoperative for INT switch setting of COUNTER switch; output frequency indicator operates normally with switch set to EXT position.	Defective counter amplifier in output frequency selection circuits (Table 4-5).
Operation normal, except output frequency indicator is inoperative with COUNTER switch set to EXT position.	Defective frequency counter circuits (Table 4-9).
Output level varies excessively as band and or output frequency is changed.	Defective output circuits (Table 4-8).
OUTPUT LEVEL meter indication is normal, but no output is available at OUTPUT connector.	Defective output circuits (Table 4-8). NOTE If instrument contains RF fuse option, RF fuse may be defective.

TABLE 4-3. SYMPTOMATIC TROUBLESHOOTING CHART

Symptom	Probable Cause of Malfunction
Output frequency indicator operates normally; OUTPUT LEVEL meter is inoperative; no output is available at OUTPUT connector (all bands and operating modes).	Defective output circuits (Table 4-8).
No AM; OUTPUT control is ineffective in control of output level.	Defective output circuits (Table 4-8).
AM operation is normal; no FM.	Defective modulation circuits (Table 4-7). Defective VFO circuits (Table 4-4).
FM operation is normal; no AM; OUTPUT control operates normally.	Defective modulation circuits (Table 4-7).
External modulation normal; no internal modulation.	Defective modulation circuits (Table 4-7).
Output normal on all bands, but output frequency indicator display is incorrect or erratic.	Defective frequency counter circuits (Table 4-9).
On Model 103D only, operation is normal in unlocked mode, but instrument will not phase lock or loses lock.	Defective phase lock circuits (Table 4-10).
No intensity marker available during sweep operation.	Defective intensity marker circuits (Table 4-11).

i. If output frequency instability persists after performing preceding step h, connect a 10 pF capacitor in place of the varactor and tracking capacitor network, and perform a new stability run. If stability is now satisfactory, replace the tracking capacitor. Remove the 10 pF capacitor.

j. Align the VFO in accordance with the procedures of paragraph 4-20.

4-14. ALIGNMENT AND ADJUSTMENT PROCEDURES.

4-15. General. Paragraphs 4-16 through 4-28 provide instructions for all adjustments and alignments required. Alignment or adjustment is not a substitute for troubleshooting. Make certain that all other possible causes of equipment malfunction have been eliminated before undertaking alignment or adjustment. Also, make certain that all required test equipment is available. See figures 4-1 and 4-2, and the printed circuit board layouts on the aprons of the schematic diagrams for the location of adjustment controls.

4-16. Test Equipment Required. Items 1 through 7 of Table 4-1 are required for complete alignment and adjustment. Test equipment having comparable performance characteristics may be substituted.

4-17. Power Supply Adjustment and Check. Proceed as follows:

a. Connect voltmeter, Weston Model 1240, between terminal A (+) and terminal C (-) of power supply printed circuit board A14.

b. Set the signal generator POWER switch to ON, and adjust potentiometer R8 on power supply printed circuit board A14 as required to obtain an indication of 15.00 ±0.1 volts on the voltmeter.

c. Connect the voltmeter between terminal C (+) and terminal D (-) of power supply printed circuit board A14. Verify that the indication on the voltmeter is 15.00 ±0.15 volts.

d. Connect the voltmeter between terminal H (+) and terminal G (-) of power supply printed circuit board A14. Verify that the indication on the voltmeter is 5.0 ±0.2 volts.

e. Connect the voltmeter between terminal G (+) and terminal F (-) of power supply printed circuit board A14. Verify that the indication on the voltmeter is 5.2 ±0.2 volts.

TABLE 4-4. SYSTEMATIC TROUBLESHOOTING CHART, VFO CIRCUITS

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
1	Remove cover shields from top of RF housing. Set POWER switch to ON position, and TUNING control to fully counterclockwise setting. Using RF millivoltmeter, Boonton Electronics Corporation Model 92B, with probe, Model 91-12F, and probe tip, Model 91-13B, measure RF signal level at terminal C of RF housing.	1 volt rms (nominal)	Proceed to step 3.	Proceed to step 2.
2	Remove cover shield from VFO housing. Using same test equipment as in step 1, measure RF signal level at RF IN terminal of buffer amplifier printed circuit board A4.	0.25 volt rms (nominal)	Check transistor A4Q1 and associated circuitry.	Check transistor Q1901 and associated circuitry on VFO board. Isolate defective part.
3	Using DC voltmeter, Weston Model 1240, measure DC voltage between terminal C on VFO housing and ground.	7.5 volts	Proceed to step 4.	Check resistors A3R8 and A3R7, and potentiometer R41b; on Model 103D, also check amplifier A1606 and associated circuitry on phase detector printed circuit board in phase lock housing. Isolate defective part.
4	Set COUNTER switch to INT position and FREQUENCY MHz switch to band 10. Observe output frequency indicator display as unlock VERNIER control is rotated.	Display is adjustable over range of approximately 25 kHz.	VFO circuits are operating normally.	Check varactors CR1901 and CR1902 and associated circuitry on VFO board in VFO housing. Isolate defective part.

TABLE 4-5. SYSTEMATIC TROUBLESHOOTING CHART, OUTPUT FREQUENCY SELECTION CIRCUITS

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
1	Remove cover shield from RF housing. Set POWER switch to ON position. Using RF millivoltmeter, Boonton Electronics Corporation Model 92B, with probe, Model 91-12F, and probe tip, Model 91-13B, measure RF signal amplitude at RF IN terminal on frequency divider printed circuit board A13.	1 volt rms (nominal)	Proceed to step 2.	VFO circuits are defective. (Refer to Table 4-4.)
2	Set FREQUENCY MHz switch to 64-138 (band 10). Using same test equipment, measure RF signal amplitude at RF OUT terminal of frequency divider printed circuit board A13.	0.3 volt rms (nominal)	Proceed to step 3.	Check integrated circuit A13IC1-A13IC3, RF transformer A13T1, relay A13K1, and associated circuitry. Isolate defective part.
3	Same as in step 2, except set FREQUENCY MHz switch to 32-64 position (band 9).	0.3 volt rms (nominal	Proceed to step 4.	Check integrated circuits A13IC1 and A13IC3, and associated circuitry. Isolate defective part.
4	Same as in step 2, except set FREQUENCY MHz switch to 16-32 position (band 8).	0.4 volt rms (nominal)	Proceed to step 5.	Check integrated circuit A13IC3 and associated circuitry. Isolate defective part.
5	Same as in step 2, except set FREQUENCY MHz switch to 8-16 position (band 7).	0.4 volt rms (nominal)	Proceed to step 6.	Check integrated circuits A13IC5, A13IC6 and A13IC7 and associated circuitry. Isolate defective part.
6	Same as in step 2, except set FREQUENCY MHz switch to 4-8 position (band 6).	0.4 volt rms (nominal)	Proceed to step 7.	Check integrated circuits A13IC5, A13IC6 and A13IC7 and associated circuitry. Isolate defective part.

TABLE 4-5. SYSTEMATIC TROUBLESHOOTING CHART, OUTPUT FREQUENCY SELECTION CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
7	Same as in step 2, except set FREQUENCY MHz switch to 2-4 position (band 5).	0.4 volt rms (nominal)	Proceed to step 8.	Check integrated circuits A13IC5, A13IC6, and A13IC7 and associated circuitry. Isolate defective part.
8	Same as in step 2, except set FREQUENCY MHz switch to 1-2 position (band 4).	0.4 volt rms (nominal)	Proceed to step 9.	Check integrated circuits A13IC5, A13IC6, and A13IC7 and associated circuitry. Isolate defective part.
9	Same as in step 2, except set FREQUENCY MHz switch to 0.5-1 position (band 3).	0.4 volt rms (nominal)	Proceed to step 10.	Check integrated circuits A13IC5, A13IC6, and A13IC7 and associated circuitry. Isolate defective part.
10	Same as in step 2, except set FREQUENCY MHz switch to 0.25-0.5 position (band 2).	0.4 volt rms (nominal)	Proceed to step 11.	Check integrated circuits A13IC5, A13IC6, and A13IC7 and associated circuitry. Isolate defective part.
11	Same as in step 2, except set FREQUENCY MHz switch to 0.125-0.25 position (band 1).	0.4 volt rms (nominal)	Proceed to step 12.	Check integrated circuits A13IC5, A13IC6, and A13IC7 and associated circuitry. Isolate defective part.
12	Ascertain that SWEEP switch is set to OFF position. Set FREQUENCY MHz switch to any band other than band 11. Using same test equipment as in step 2, measure RF signal amplitude at RF OUT terminal of driver printed circuit board A8.	0.5 to 1.5 volts rms (nominal)	Proceed to step 13.	Check relays A8K1, A8K2, and A8K3, transistor A8Q4, and associated circuitry. Isolate defective part.
13	Set FREQUENCY MHz switch to band 11, and measure RF signal amplitude at RF OUT terminal of driver printed circuit board A8, using same test equipment as in step 2.	0.5 to 1.0 volt rms (nominal)	Proceed to step 14.	Check relay A8K1, A8K2, transistors A8Q1 and A8Q2, crystal A8Y1, mixer A8Z1, and associated circuitry. Isolate defective part.

TABLE 4-5. SYSTEMATIC TROUBLESHOOTING CHART, OUTPUT FREQUENCY SELECTION CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
14	Set FREQUENCY MHz switch to band 1, 2, 4, 7, or 10. Set SWEEP switch to ON position, and measure RF signal amplitude at terminal 7 or relay A8K4 on driver printed circuit board A8, using same test equipment as in step 2.	0.2 volt rms (nominal)	Proceed to step 15.	Sweep oscillator circuits are defective. (Refer to Table 4-6).
15	Without disturbing control settings, measure RF signal amplitude at RF OUT terminal of driver printed circuit board A8, using same test equipment as in Step 2.	0.5 to 1.0 volt rms (nominal)	Proceed to step 16.	Check relay A8K4, SWEEP switch section S8b, and associated circuitry. Isolate defective part.
16	Set COUNTER switch to INT position. Measure RF signal amplitude at COUNTER OUT terminal of driver printed circuit board A8, using same test equipment as in step 2.	0.5 to 1.0 volt rms (nominal)	Output frequency selection circuits are operating normally.	Check transistors A8Q3 and A8Q5, and associated circuitry. Isolate defective part.

4-18. Modulation Oscillator. Adjust the modulation oscillator circuit as follows:

a. Connect AC voltmeter, Boonton Model 93A, to the OUT connector on the front panel of the signal generator.

b. Press the AM INT switch, and set the MOD FREQ kHz switch to 1.

c. Adjust potentiometer R31 on modulation printed circuit board A41 as required to obtain an indication of 2.3 volts rms on the AC voltmeter.

d. Disconnect the AC voltmeter, and connect distortion analyzer, Hewlett Packard Model 333A, to the OUT (BNC) connector of the signal generator. Measure the distortion. The distortion should not exceed 0.2%.

4-19. Frequency Accuracy Adjustment. Correct any internal frequency counter inaccuracy as follows:

a. Set the signal generator controls as follows:

Control	Position
AM OFF switch	Depressed
FM OFF switch	Depressed
COUNTER INT switch	Depressed
RESOLUTION Hz switch	10
SWEEP switch	OFF
FREQUENCY MHz switch	64-138
TUNING control	100.00000 indication on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter

TABLE 4-6. SYSTEMATIC TROUBLESHOOTING CHART, SWEEP OSCILLATOR CIRCUITS

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
1	Remove cover shields from RF housing. Set POWER switch to ON position, SWEEP switch to ON position, and MOD FREQ kHz switch to any position other than LINE Hz RAMP position. Using RF millivoltmeter, Boonton Electronics Corporation Model 92B, with probe, Model 91-12F, and probe tip, Model 91-13B, measure RF signal level at terminal 7 of relay A8K4 on driver printed circuit board A8 as FREQUENCY MHz switch is set successively to bands 1, 2, 4, 7, and 10.	0.2 volt rms (nominal) on each specified band.	Proceed to step 2.	If abnormal indication is obtained on all bands, check SWEEP switch section S8b, filter FL1 on RF housing, and switch section A5S1c. Isolate defective part. If abnormal indication is obtained on one band only, check following integrated circuits and associated circuitry on driver printed circuit board A8: Band 1 – A8IC1 Band 2 – A8IC2 Band 4 – A8IC3 Band 7 – A8IC4 Band 10 – A8IC5 Isolate defective part.
2	Set SWEEP switch to MKR position, and repeat measurement of RF signal level at terminal 7 of relay A8K4 on driver printed circuit board A8 with FREQUENCY MHz switch set to band 1, 2, 4, 7, or 10.	Same as in step 1.	Proceed to step 3.	Check switch section S8b. Isolate defective switch.
3	Using DC voltmeter, Weston Model 1240, measure DC voltage between VTO FM terminal on driver printed circuit board A8 and ground as unlock VERNIER control is rotated.	5.3 to +7.3 volts (nominal)	Proceed to step 4.	Check capacitor A8C4, potentiometer R41b, resistors A3R1 and A3R14, and filter A5FL5. Isolate defective part.
4	Set COUNTER switch to INT position and FREQUENCY MHz switch successively to bands 1, 2, 4, 7, and 10. At each band setting, rotate unlock VERNIER control and note effect on output frequency indicator display.	Display adjustable over range of approximately: Band 1 .25-.29 MHz 2 .43-.52 MHz 4 1.1-1.3 MHz 7 9.8-11.5 MHz 10 82-115 MHz	Sweep oscillator circuits are operating normally.	Check varactor in affected circuit (A8CR2, A8CR4, A8CR6, A8CR9, A8CR11, and A8CR12).

TABLE 4-7. SYSTEMATIC TROUBLESHOOTING CHART, MODULATION CIRCUITS

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
	FM PORTION			
1	Set FREQUENCY MHz switch to 8-16 MHz and MOD FREQ kHz switch to 0.4. Depress FM INT switch and set POWER switch to ON position. Connect distortion analyzer (HP333A) to OUT connector (BNC) on front panel. Rotate MOD FREQ kHz switch successively to 1, 3, 10, and 19 positions. Observe the output voltage (voltmeter mode).	2.3 volts rms for each switch setting (nominal)	Proceed to step 2.	Check switch sections A1S5a, A1S7c, A1S6a through A1S6e, A1S7b, and A1S8a, amplifiers A41A1 and A41A2, relay A41K1, potentiometer A1R16 and associated circuitry. Isolate defective part in circuit of modulation oscillator A41A6 or emitter follower A41A7 through voltage measurements. Isolate defective part.
2	On band 7, set FM control to produce 0.8 volt indication at terminal B of VFO housing with a deviation kHz setting of 100. Set FREQUENCY MHz switch successively to bands 8, 9, 10, and 11, and measure AF signal amplitude at terminal B of VFO housing on each band, using distortion analyzer. (voltmeter mode).	0.4 volt rms, 0.2 volt rms, 0.1 volt rms, 0.2 volt rms, for bands 8, 9, 10, and 11, respectively	Proceed to step 3.	Check switch sections A1S7a and A1S7b, and associated resistive attenuation networks. Isolate defective part.
3	Set FREQUENCY MHz switch to 8-16 position (band 7). With FM control set as in step 2, set DEVIATION kHz switch successively to 30, 10, and 3 positions, and measure AF signal amplitude at terminal B of VFO housing, using distortion analyzer.	0.25 volt rms, 0.08 volt rms, 0.025 volt rms, for ranges 30, 10, and 3 respectively	Proceed to step 4.	Check switch sections A1S6a through A1S6e and associated resistive attenuation networks. Isolate defective part.

TABLE 4-7. SYSTEMATIC TROUBLESHOOTING CHART, MODULATION CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
4	Set DEVIATION kHz switch to 300 position. With FM control set 2.5 volts rms on terminal B with the FREQUENCY MHz switch in the 32-64 MHz position, switch to bands 10 and 11, and measure AF signal amplitude at terminal B of VFO housing for each switch position, using distortion analyzer.	1.25 volts rms, band 10; 2.5 volts rms, band 11	Proceed to step 5.	Check switch sections A1S7c and A1S6e, and associated circuitry. Isolate defective part.
5	Set METER switch to FM position, and DEVIATION kHz switch to 100 position. Rotate FM control and observe effect on MODULATION meter.	MODULATION meter pointer adjustable to full scale	Proceed to step 6.	If meter indication is abnormal only for FM, check potentiometer A41R5, resistor A41R3, switch A1S4, and associated circuitry. Isolate defective part. If meter indication is abnormal for both FM and AM, check modulation detector A41A4–A41A5, switch A1S4, meter A1M1, and associated circuitry. Isolate defective part.
6	Depress FM EXT switch. Using audio oscillator, Hewlett Parkard Model 204C, apply a 1 kHz, 2 volt rms signal to FM EXT connector. Rotate FM control, and observe effect on MODULATION meter.	Meter pointer adjustable to full scale	FM portion of modulation circuits is operating normally; proceed to step 7 for AM portion troubleshooting.	Check switch A1S5a and associated circuitry on main frame. Isolate defective part.

TABLE 4-7. SYSTEMATIC TROUBLESHOOTING CHART, MODULATION CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
	AM PORTION			
7	Depress AM INT switch, and set AM control fully clockwise. Using OUTPUT control, set pointer of OUTPUT LEVEL meter to 0 dBm. Using distortion analyzer, measure AF signal amplitude at terminal P of RF housing.	0.5 volt rms (nominal)	Proceed to step 8.	Isolate defective part in circuit of amplifier A3A1 or A3A2 through voltage measurements; check switch section A1S5b, AM control A1R27, and associated circuitry on main frame. Isolate defective part.
8	With distortion analyzer connected as in step 7, adjust AM control as required to obtain 0.2 volt indication on distortion analyzer meter. Set METER switch to 100% AM, and observe indication on MODULATION meter.	Approximately 40 on MODULATION meter scale	Proceed to step 9.	Check switch A1S4 and associated circuitry on main frame. Isolate defective part.
9	Depress AM EXT switch. Using audio oscillator, Hewlett Packard Model 204C, apply a 1 kHz, 1 volt rms signal to EXT AM connector. Set METER switch to 30% AM. Rotate AM control and observe effect on MODULATION meter.	Meter pointer adjustable to full scale	AM portion of modulation circuits is operating normally. Proceed to step 10 for sweep portion checks. (If AM is still unavailable at instrument output, check output circuits (Table 4-8).	Check switch section A1S5b and associated circuitry on main frame. Isolate defective part.

TABLE 4-7. SYSTEMATIC TROUBLESHOOTING CHART, MODULATION CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
		SWEEP PORTION		
		NOTE The following troubleshooting procedure is based on the assumption that the FM portion has been checked and is operating normally.		
10	Depress AM OFF and FM INT switches. Set MOD FREQ kHz switch to LINE Hz RAMP position. Connect oscilloscope, Tektronix Model 5103N, to OUT (BNC) connector on front panel. Observe waveform on oscilloscope.	60 Hz ramp, 5 volts peak-to peak amplitude, (nominal).	Proceed to step 11.	Proceed to step 11.
11	Using DC voltmeter, Weston Model 1240, measure DC voltage between terminal K of modulation printed circuit board A41 and ground.	+15 volts DC	Proceed to step 12.	Check switch sections A1S3d and A1S5a. Isolate defective part.
12	Using oscilloscope, check waveform at terminal F of modulation circuit board A41.	60 Hz ramp, 5 volts peak-to-peak amplitude	Check integrated circuit A41A7 and associated circuitry. Replace defective part.	Check integrated circuit A41IC2, transistor A41Q1, amplifier A41A3, and associated circuitry. Isolate defective part.
13	Using oscilloscope, check waveform at terminal F of RF housing with FREQUENCY MHz switch set successively to bands 1, 2, 4, 7, and 10, DEVIATION kHz switch set to 300 position, and FM control set for full scale indication on MODULATION meter A1M1.	60 Hz ramp: Band — Nominal p-p volts 1 — 2.4 2 — 1.5 4 — 2.3 7 — 2.0 10 — 1.0	Sweep portion is operating normally. If frequency sweep operation is still not possible, check sweep oscillator circuits (Table 4-6) and output frequency selection circuits (Table 4-5).	Check switch section A1S7e and sweep calibration circuits on meter printed circuit board A3. Isolate defective part.

TABLE 4-8. SYSTEMATIC TROUBLESHOOTING CHART, OUTPUT CIRCUITS

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
1	Remove cover shields from RF housing. Depress AM OFF and FM OFF switches. Set SWEEP switch to OFF position, RF switch to ON position, and POWER switch to ON position. Using RF millivoltmeter, Boonton Electronics Corporation Model 92B, with probe, Model 92-12F, and probe tip, Model 91-13B, measure RF signal amplitude at terminal R of RF housing for each position of FREQUENCY MHz switch.	Adjustable to 1 volt rms, minimum, on each band, using OUTPUT control	Proceed to step 12.	Proceed to step 2.
2	Using same test equipment and switch settings as in step 1, measure RF signal amplitude at RF IN terminal of modulator on output printed circuit board A8 for each position of FREQUENCY MHz switch.	0.5-1.0 volt rms (nominal) on each band	Proceed to step 3.	Trouble is in output frequency selection or VFO circuits. (Refer to Table 4-5 or 4-4.)
3	Set the RF output to 0 dBm with the attenuator on the 300 MV output range. Set TUNING control fully counterclockwise. Measure RF signal amplitude at RF IN terminal of filter printed circuit board A9, using same test equipment as in step 1.	0.03 volt rms	Proceed to step 6.	Proceed to step 4.
4	Measure DC voltage between terminal 6 of AGC amplifier A7A1 and ground as OUTPUT control is adjusted, using DC voltmeter, Weston Model 1240. Switch output to 3V range and repeat.	Voltage adjustable over range of +0.5 to +2.5 volts by means of OUTPUT control. On 3V range, voltage is adjustable from +0.9 to +5.5 VDC	Proceed to step 5.	Check amplifiers A7A1 and A3A2, switch section A1S12a, potentiometer A1R42, and associated circuitry. Isolate defective part.

TABLE 4-8. SYSTEMATIC TROUBLESHOOTING CHART, OUTPUT CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
5	Using DC voltmeter, Weston Model 1240, measure DC voltage between pin 8 of filter printed circuit board A9 and ground with TUNING control set fully counter-clockwise.	-0 volt DC	Check modulator diodes A7CR1 through A7CR8, RF transformers A7T1 and A7T2, and associated circuitry. Replace defective part.	Check cam-operated switch A1S11, filter A5FL15, and associated circuitry. Isolate defective part.
6	Set output as in step 3. Set TUNING control fully clockwise. Using same test equipment as in step 1, measure RF signal amplitude at RF IN terminal of filter printed circuit board A9.	0.03 volt rms	Proceed to step 8.	Proceed to step 7.
7	Same as in step 5, except set TUNING control fully clockwise.	+5 volts DC	Proceed to step 8.	Check cam-operated switch A1S11. Isolate defective switch.
8	With TUNING control set fully clockwise, measure RF signal amplitude at RF OUT terminal of filter printed circuit board A9 for each position of FREQUENCY MHz switch, using same test equipment as in step 1.	0.01 volt rms	Proceed to step 9.	If indication is not normal on all bands, check capacitors A9C1 and A9C96, switch section A5S1f, and associated circuitry. Isolate defective part. If indication is not normal on only one band, check associated band filter components, switch section A5S1f, and associated circuitry. Isolate defective part.
9	With TUNING control fully counterclockwise, measure RF signal amplitude at RF OUT terminal of filter printed circuit board A9 for each position of FREQUENCY MHz switch.	0.01 volt rms	Proceed to step 10.	If indication is not normal on all bands, check capacitors A9C1 and A9C96. Isolate defective parts. If indication is not normal on only one band, check associated band filter components. Isolate defective part.

TABLE 4-8. SYSTEMATIC TROUBLESHOOTING CHART, OUTPUT CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
10	Using same test equipment as in step 1, measure RF signal amplitude at RF OUT terminal of Optimax amplifier on output printed circuit board A7.	Adjustable to at least 1 volt rms on each frequency band	Proceed to step 11.	Check Optimax amplifier and associated circuitry on output printed circuit board A7. Isolate defective part.
11	Rotate OUTPUT control and note effect on OUTPUT LEVEL meter indication.	Meter pointer adjustable over full scale	Proceed to step 12.	Isolate defective part in circuits of diode demodulator A7CR9, amplifier A7A2, and meter A1M2 through voltage and resistance checks. Isolate defective part.
12	Set FREQUENCY MHz switch successively to each of 11 bands. On each band, tune slowly over entire band, and note effect on OUTPUT LEVEL meter indication.	Meter indication remains constant within +0.5 dB	Proceed to step 13.	Isolate defective part in circuit of amplifier A7A1 through voltage measurements. Isolate defective part.
13	Connect power detector of microwattmeter, Boonton Electronics Corporation, Model 42B, to OUTPUT connector. Rotate OUTPUT LEVEL attenuator successively to each of its positions and observe indication on microwattmeter.	Indication corresponds to output level indicated by attenuator setting and OUTPUT LEVEL meter indication	Proceed to step 14.	Check OUTPUT LEVEL attenuator. (If instrument is equipped with RF fuse option, also check RF fuse.) Isolate defective part.
14	With test equipment connected as in step 13, set RF switch to 3V position, reset the output meter indication to 0 dB, and observe effect on microwattmeter indication.	Indication increases by 10 dB when switch is actuated	Proceed to step 15.	Check RF switch section A1S12b, resistor A1R44, associated circuitry. Isolate defective part.

TABLE 4-8. SYSTEMATIC TROUBLESHOOTING CHART, OUTPUT CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
15	Press AM INT switch. Set METER switch to 100% AM position, and MOD FREQ kHz switch to .4 position. Using AM control, position pointer of MODULATION meter to 50. Set RF switch to ON position. Using OUTPUT control, position pointer of OUTPUT LEVEL meter to 0 dBm. Set function switch on distortion analyzer, Hewlett Packard Model 333A, to voltmeter position, and measure AF signal amplitude at junction of resistors A7R13 and A7R15 with distortion analyzer.	1.4 volts rms (nominal)	Proceed to step 16.	Ascertain that modulation circuits are operating properly. (Refer to Table 4-7.) Then, isolate defective part in circuits of amplifier A7A1, diode modulator, or diode demodulator A7CR9 through voltage measurements. Isolate defective part.
16	With controls set as in step 15, measure AF signal amplitude at DEMOD AM OUT connector, using distortion analyzer.	1.4 volts rms (nominal)	Output circuits are operating normally.	Check amplifier A7A3 and associated circuitry. Isolate defective part.

b. Allow the signal generator to warm up for at least 2 hours.

c. Connect frequency counter, Hewlett Packard Model 5300B/5303B/5311B, OPT 001, to the OUTPUT connector of the signal generator, and check the frequency of the signal generator output.

d. Compare the frequency indication on the external frequency counter with that on the signal generator output frequency indicator. The two indications should agree within 100 Hz. If necessary, adjust the adjusting screw of clock oscillator Y1 on display time base printed circuit board A16 as required to make the two indications coincide within the specified limit.

4-20. FM Tracking and VFO Alignment. Proceed as follows:

a. Connect modulation meter, Boonton Model 82AD, to the OUTPUT connector of the signal generator.

b. Set the signal generator controls as follows:

Control	Position
METER switch	FM
DEVIATION kHz switch	100
MOD FREQ kHz switch	1
FM INT switch	Pressed in
AM OFF switch	Pressed in
FREQUENCY MHz switch	64-138
TUNING control	138 MHz on output frequency indicator
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
RESOLUTION Hz switch	1k
SWEEP switch	OFF
RF switch	ON

c. Set the modulation meter to the 100 kHz deviation range (30 Hz to 15 kHz bandwidth). Advance the FM control on the signal generator to the point where an indication of 100 kHz is obtained on the modulation meter.

d. Tune the signal generator to 135 MHz and note the indication on the modulation meter. If the indication is greater than 100 kHz, spread the segmented rotor plates of deviation tracking capacitor C1913 in the VFO circuit until a 100 kHz indication is obtained. Conversely, adjust the segmented plates closer to the stator plates if the modulation meter indication is less than 100 kHz. When adjusting the plates, make sure that all four rotor plates are symmetrically spread from the stators. The segments of the rotor that are to be adjusted are those having just gone into mesh at the frequency of interest.

e. In a similar manner, tune the signal generator down the band in 5 MHz increments, and adjust the rotor segments as required to maintain a deviation of 100 ±3 kHz at each tuning increment.

f. Tune slowly across the entire band and verify that all frequencies exhibit a deviation of 100 ±3 kHz. If necessary, readjust the segmented rotor plates of the deviation tracking capacitor until the requirements of this step are met.

g. Press the FM OFF switch. Tune the signal generator to the low frequency end of band 10 (64-138 MHz). Adjust the end stop of the VFO drive mechanism as required to obtain a low frequency limit of 62.75 ±0.25 MHz.

h. Tune the signal generator to the high frequency end of band 10. Adjust the high frequency end stop of the VFO drive mechanism as required to obtain a high frequency limit of 139.0 MHz minimum.

i. Turn the VERNIER control to the full counterclockwise position. Using the TUNING control, set the output frequency of the signal generator to 100.000 MHz, as indicated on the output frequency indicator. Turn the VERNIER control to the full clockwise position, and note the change in the output frequency indication on the output frequency indicator. The change should be 0.025 ±.008 MHz.

j. Tune the signal generator to 94.000 MHz. Adjust the mechanical position of the microswitch on the VFO drive mechanism so that the switch actuates at 94.000 ±.5 MHz when this frequency is approached in either direction of the main tuning shaft. An audible click can be heard at the moment of switch actuation.

4-21. Band 11 Oscillator and Filter Adjustments. Proceed as follows:

a. Set the signal generator controls as follows:

Control	Position
AM OFF switch	Depressed
FM OFF switch	Depressed
FREQUENCY MHz switch	64-138
TUNING control	94 MHz on output frequency indicator
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
RF switch	ON

b. Connect spectrum analyzer, Hewlett Packard Model 140T/8552B/8554B, to the OUTPUT connector of the signal generator. Center the spectrum analyzer display at approximately 150 MHz with a 50 MHz/division scan.

c. Set the FREQUENCY MHz switch to 138-175. Adjust capacitor C17 on driver printed circuit board A8 as required to produce a maximum amplitude signal at 153 MHz on the spectrum analyzer display.

d. Connect a clip lead from the junction of resistors R1 and R2 on output printed circuit board A7 to ground. This disables the agc.

e. Tune the signal generator across the band, and adjust capacitors C87, C88 and C92 on filter printed circuit board A9 (low half of the band) and capacitors C77, C78, and C82 on filter printed circuit board A9 (high half of the band) for flattest response over the band.

f. Tune slowly across the band and readjust capacitor C17 on driver printed circuit board A8 as required for optimum suppression of spurious mixing products which cross through the desired output frequency. Verify that all spurious mixing products are more than 30 dB below the desired output.

g. Disconnect the clip lead.

TABLE 4-9. SYSTEMATIC TROUBLESHOOTING CHART, FREQUENCY COUNTER CIRCUITS

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
1	Set COUNTER switch to INT position, SWEEP switch to OFF position, RESOLUTION Hz switch to 10 position, and POWER switch to ON position. Set FREQUENCY MHz switch to each band in succession and tune over each band, using TUNING control, while observing output frequency indicator display.	Display operates correctly on every band	Proceed to step 9.	If display fails to operate on every band, but does function for external signal measurements, check relays A10K1, and A13K2, counter amplifier A8Q3-A8Q5, and associated circuitry. Isolate defective part. If display is inoperative for both internal and external signal measurements, proceed to step 2.
2	Using oscilloscope, Hewlett Packard 1740, measure RF signal amplitude at terminal H of RF housing.	0.6 volt peak-to-peak (nominal) for each position of FREQUENCY MHz switch	Proceed to step 4.	Proceed to step 3.
3	Set FREQUENCY MHz switch to band 1, and RESOLUTION Hz switch to 1 position. Measure RF signal amplitude at terminal H of RF housing, using same test equipment as in step 2.	0.6 volt peak-to-peak (nominal)	Proceed to step 4.	Check transistors A10Q1 and A10Q2, integrated circuits A10IC1, A10IC2, A10IC4, A10IC6, and associated circuitry. Isolate defective part.
4	Using oscilloscope, check waveform at terminal P1-X of display time base printed circuit board A16 with RESOLUTION Hz switch set successively to 1, 10, 100, and 1k positions.	4 volt peak-to-peak gate pulses obtained for each switch setting	Proceed to step 8.	Proceed to step 5.
5	Using oscilloscope, check waveform at test point TP1 on display time base printed circuit board A16.	1 MHz signal, 3.5 volt peak-to-peak amplitude	Proceed to step 6.	Check crystal oscillator A16Y1 and associated circuitry. Isolate defective part.

TABLE 4-9. SYSTEMATIC TROUBLESHOOTING CHART, FREQUENCY COUNTER CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
6	Check waveform at terminal 11 of integrated circuit A16IC12, using oscilloscope.	1 second duration pulse, 3 volt peak-to-peak amplitude	Proceed to step 7.	Check for output pulses at terminal 11 of integrated circuits A16IC2, A16IC5, A16IC7, A16IC8, and A16IC10 in succession. Check integrated circuit at which pulses are first absent, and associated circuitry. Isolate defective part.
7	Set RESOLUTION Hz switch to 1000 position. Using oscilloscope, check waveform at terminal P1-Y of display time base printed circuit board A16.	4 volt peak-to-peak pulses, with period of 20 ms.	Proceed to step 8.	Check integrated circuits A16IC11, A16IC3, and A16IC4, and associated circuitry. Isolate defective part.
8	Using oscilloscope, check waveform at terminal P1-Z of display time base printed circuit board A16.	0.3 volt peak-to-peak negative pulses with period of 20 ms.	Isolate defective part on display printed circuit board A2 through waveform and voltage checks. Replace defective part.	Check integrated circuit A16IC11, transistor A16Q1, and associated circuitry. Isolate defective part.
9	Set FREQUENCY MHz switch to band 1, and RESOLUTION Hz switch to 1 position. Observe output frequency indicator display.	Decimal point in front of first digit of display	Proceed to step 10.	Check integrated circuit A16IC6, switch section S10b, and associated circuitry. Isolate defective part.
10	Set FREQUENCY MHz switch to bands 8, 9, 10, and 11 in succession.	16 MHz MAX indicator flashes	Proceed to step 11.	Check integrated circuits A16IC4 and A16IC1, indicator CR3, and associated circuitry. Isolate defective part.
11	Set FREQUENCY MHz switch to band 6. Set RESOLUTION Hz switch successively to 10, 100, and 1K positions. Observe output frequency indicator display.	Decimal point moves one digit to right each time switch position is advanced	Proceed to step 12.	Check integrated circuit A16IC3, switch section S10c, and associated circuitry. Isolate defective part.

TABLE 4-9. SYSTEMATIC TROUBLESHOOTING CHART, FREQUENCY COUNTER CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
12	Set RESOLUTION Hz switch to 1 position and COUNTER switch to EXT position. Connect audio oscillator, Hewlett Packard Model 204C, to COUNTER EXT connector on front panel. Set audio oscillator controls to provide 1000 Hz, 1 volt output signal, and observe output frequency indicator display.	.001000 (nominal)	Frequency counter circuits are operating normally.	Check relay A10K1 and associated circuitry. Isolate defective part.

4-22. **RF Output Adjustments.** Proceed as follows:

a. Set the signal generator controls as follows:

Control	Position
AM OFF switch	Depressed
FM OFF switch	Depressed
FREQUENCY MHz switch	32-64
OUTPUT LEVEL attenuator	0 dBm

b. Connect the RF output of the signal generator to the power detector of a microwattmeter (BEC 42B).

c. Set the POWER switch to OFF and adjust the mechanical zero of the signal generator OUTPUT LEVEL meter to produce a zero indication.

d. Set the POWER switch to ON and the output RF switch to OFF. Adjust potentiometer R23 on meter printed circuit board A3 to produce a zero indication, exactly, on the OUTPUT LEVEL meter.

e. Set the RF output switch to ON and the output frequency to 50 MHz. Adjust the OUTPUT LEVEL control to produce a reading of 0 dBm, exactly, on the microwattmeter.

f. Adjust potentiometer R20 on meter printed circuit board A3 to produce a reading of 0 dB, exactly, on the signal generator OUTPUT LEVEL meter.

4-23. **Modulation Adjustments.** Proceed as follows:

a. Set the signal generator controls as follows:

Control	Position
AM OFF switch	Depressed
FM OFF switch	Depressed
MOD FREQ kHz switch	1
FREQUENCY MHz switch	64-138
TUNING control	100 MHz on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
RF switch	ON

b. Set the POWER switch to OFF. Using the mechanical zero adjusting screw of the MODULATION meter, zero the meter indication.

c. Set the POWER switch to ON. Adjust potentiometer R27 on modulation printed circuit board A41 as required to produce a zero indication, exactly, on the MODULATION meter.

d. Connect modulation meter, Boonton Model 82AD, to the signal generator OUTPUT connector. Depress the FM INT switch on the signal generator, and advance the

TABLE 4-10. SYSTEMATIC TROUBLESHOOTING CHART, PHASE LOCK CIRCUITS

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
1	If spare phase-lock counter, phase detector, and phase-lock time base printed-circuit boards are available, localize problem by replacing printed circuit boards one at a time. If spares are not available, proceed to step 2.	Normal lock operation.	Replace or repair defective printed circuit board.	Proceed to step 2.
2	Using oscilloscope, Hewlett Packard 1740, check clock input at test point TP4 on phase-lock counter printed-circuit board.	Waveform as shown in figure 6-22	Proceed to step 3.	Localize defective circuit in frequency divider printed circuit board in RF housing through waveform and voltage checks. Check transistor Q1201, and integrated circuits IC1201 through IC1203. Isolate defective parts.
3	Disconnect clock lead, remove phase-lock counter printed-circuit board, and install extender card, Model 92-6A, in its place. Install phase-lock counter printed-circuit board on card extender. Using short clip lead, connect clock input to phase-lock printed-circuit board, and check waveforms using same test equipment as in step 2.	Waveform as shown in figure 6-22	Proceed to step 5.	If waveform at TP3 is not normal, proceed to step 4. If waveform at TP5 is not normal, check for defective integrated circuit IC1704 and/or defective LOCK/UNLOCK switch. Isolate defective part. If waveform at TP1 is not normal, check for defective integrated circuit IC1716, IC1718, IC1715, IC1713, IC1710, IC1707, IC1711, or IC1708. Isolate defective part. If waveform at TP2 is not normal, check for defective integrated circuit IC1703, IC1702, IC1701, IC1708, IC1716, IC1705, IC1717, IC1714, IC1712, IC1709, IC1706, or IC1711. Isolate defective part.

TABLE 4-10. SYSTEMATIC TROUBLESHOOTING CHART, PHASE LOCK CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
4	Install phase lock counter printed circuit board in its normal location. Remove phase lock time base printed circuit board and install extender card, Model 92-6A, in its place. Install phase lock time base printed circuit board on extender card and check waveforms, using same test equipment as in step 2.	Waveforms as shown in figure 6-20	Proceed to step 5.	If waveform at TP1 is not normal, check DC voltages (Table 4-23); if normal, check for defective integrated circuit IC1501 or Y1501. Isolate defective part. If waveform at TP2 is not normal, check for defective integrated circuit IC1501, transistor Q1501, or associated circuit parts. If waveform at TP3 and/or TP4 is not normal, check for defective integrated circuit IC1502, IC1503, IC1504, IC1505, or IC1506. Isolate defective part.
5	Install phase-lock time base printed-circuit board in its normal location. Remove phase detector printed-circuit board and install extender card, Model 92-6A, in its place. Install phase-lock time base printed-circuit board on extender card and check waveforms, using same test equipment as in step 2.	Waveforms as shown in figure 6-21	Instrument should be locking properly.	If waveform at TP1, TP2, and/or TP3 is not normal, check for defective integrated circuit IC1601 or IC1602, transistor Q1602 or Q1603, or amplifier A1601, A1604, A1605, or A1606. Isolate defective part. If waveform at TP4 is not normal, check for defective integrated circuit IC1603. Isolate defective part. If instrument locks but phase lock indicator malfunctions, check for defective amplifier A1602 or A1603, integrated circuit IC1604, transistor Q1605, diode CR1601 or CR1602, or phase lock indicator CR4. Isolate defective part.

TABLE 4-11. SYSTEMATIC TROUBLESHOOTING CHART, INTENSITY MARKER CIRCUITS

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
1	Remove cover shields from top of RF housing. Set POWER switch to ON position. Set FREQUENCY MHz switch to band 7 (8-16). Set MOD FREQ kHz switch to LINE Hz RAMP position. Set SWEEP switch to ON position and adjust VERNIER control for 10.7 MHz indication on output frequency incicator. Set SWEEP switch to MKR position, and set DEVIATION kHz switch to 100 position. Using oscilloscope, Tektronix 5103N, observe output waveform at INTENSITY MARKER OUT connector on rear panel.	+4 volt peak amplitude, 60 microsecond pulse, 50 or 60 Hz repetition frequency	Proceed to step 10.	Proceed to step 2.
2	Using RF millivoltmeter, Boonton Electronics Corp. Model 92B with probe, Model 92-12F, and probe tip, Model 91-13B, measure signal amplitude at base of transistor A6Q1.	0.35 volt rms	Proceed to step 4.	Proceed to step 3.
3	Using DC voltmeter, Weston Model 1240, measure DC voltage between base of transistor A6Q2 and ground.	+0.7 volt DC	Check transistor A6Q2, relay A6K1, transistor A8Q6, and associated circuitry; check coaxial cable connections between driver and intensity marker printed circuit boards.	Check switch sections A5S1b and A1S8c, integrated circuit A6IC1, transistors A6Q5, A6Q6, and A6Q3, and associated circuitry.
4	Using same test equipment as in step 2, measure signal amplitude across resistor A6R9.	0.2 volt rms	Proceed to step 5.	Check integrated circuit A13IC1e and associated circuitry; check coaxial cable connections between frequency divider and intensity marker printed circuit boards.

TABLE 4-11. SYSTEMATIC TROUBLESHOOTING CHART, INTENSITY MARKER CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication Is Normal	If Indication Is Abnormal
5	Using oscilloscope, Tektronix 5103N, synchronized to power line, check signal waveform at test point TP1 on intensity marker printed circuit board A6.	Waveform as shown in figure 4-3, amplitude 0.2 volt peak-to-peak	Proceed to step 6.	Check transistor A6Q1, mixer A6Z1, and associated circuitry.
6	Using oscilloscope, check signal waveform at test point TP2 on intensity marker printed circuit board A6.	Waveform as shown in figure 4-3, amplitude 10 volts peak-to-peak	Proceed to step 7.	Check integrated circuit A6A1 and associated circuitry.
7	Using DC voltmeter, measure DC voltage between test point TP3 on intensity marker printed circuit board A6 and ground.	2.4 volts DC	Proceed to step 8.	Check integrated circuit A6IC2, transistor A6Q4 and associated circuitry; check filter A5FL3 and switch sections A1S6f and A1S8b.
8	Using oscilloscope, observe waveform at test point TP4 on intensity marker printed circuit board A6.	Waveform as shown in figure 4-3, amplitude 5 volt peak	Proceed to step 9.	Check integrated circuit A6A2, detector A6CR2-A6CR3, and associated circuitry.
9	Using oscilloscope, observe waveform at terminal 1 of integrated circuit A6IC4.	Waveform as shown in figure 4-3, amplitude 3.5 volt peak	Check integrated circuit A6IC5 and associated circuitry.	Check integrated circuits A6IC3 and A6IC4 and associated circuitry.
10	Repeat step 1, except with DEVIATION kHz switch set to 300 position.	Same as in step 1.	Proceed to step 11.	Check transistor A6Q4, integrated circuits A6IC2 and A6IC3, and associated circuitry.
11	Repeat step 1, except with FREQUENCY MHz switch set to band 10 (64-138), DEVIATION kHz switch set to 300 position, and VERNIER control adjusted for 98.0 MHz indication on output frequency indicator.	Same as in step 1.	Intensity marker circuits are operating normally.	Check transistor A6Q6, integrated circuits A6IC2 and A6IC3, and associated circuitry.

COMPAGNIE MARCONI CANADA

SERVICE DES INSTRUMENTS ELECTRONIQUES

G A R A N T I E

Les instruments électroniques vendus par Compagnie Marconi Canada (CMC) sont garantis contre tout défaut de matériel ou de fabrication. Si de telles défectuosités surviennent dans les 12 mois après la date de livraison à l'acheteur initial, elles seront réparées ou l'instrument électronique remplacé par CMC, sans frais pour l'acheteur initial, POURVU QUE:

(a) l'acheteur initial avise promptement CMC de la défectuosité et fournisse la preuve que ledit instrument électronique a été bien entretenu et utilisé aux seules fins auxquelles il est destiné, et non soumis à un usage abusif (dans ce dernier cas, la décision de CMC sera finale et sans recours);

(b) l'acheteur initial retourne à ses frais l'instrument électronique défectueux à CMC a/s du service des instruments électroniques, Montréal, Québec, (ledit instrument électronique réparé ou remplacé en vertu de la présente garantie sera retourné à l'acheteur initial aux frais de CMC). En aucun temps CMC sera responsable pour la perte d'usage de l'instrument électronique et/ou pour tout dommage direct, indirect et/ou incident.

La présente garantie est la seule responsabilité de CMC et tient lieu de toute autre garantie formelle ou implicite.

NO DU MODELE NO DE SERIE

VERIFIE PAR DATE DE LA GARANTIE

Cet instrument électronique a été inspecté à fond et son fonctionnement vérifié avant la livraison; s'il est endommagé à la réception, faites une réclamation au transporteur et avisez immédiatement CMC, Service de Réparations des Instruments Electroniques, des dommages constatés.

S'il faut retourner l'instrument électronique pour réparation, faites le parvenir à:

COMPAGNIE MARCONI CANADA
SERVICE DE REPARATIONS DES INSTRUMENTS ELECTRONIQUES,
320, rue Aberdare,
Porte 10,
MONTREAL, QUEBEC

TELEPHONE (514) 341-7630 Poste 560

CANADIAN MARCONI COMPANY

ELECTRONIC INSTRUMENTS DEPARTMENT

W A R R A N T Y

Canadian Marconi Company (CMC) warrants each new Electronic Instrument sold by it to be free from defects in material and workmanship, and any Electronic Instrument which so proves defective within 12 months from date of delivery shall be repaired or replaced by CMC free of charge to the original purchaser, PROVIDED:

(a) that CMC receives prompt notice of defect and satisfactory proof thereof establishing that the said Electronic Instrument has been properly maintained and operated within the limits of rated capacity and was not subjected to abuses (CMC's decision in this last instance shall be final and without recourse);

(b) that original purchaser returns the said defective Electronic Instrument to CMC, c/o Electronic Instruments Department, Montreal, Quebec, and assumes all expenses for the transportation (repaired or replaced Electronic Instruments will be returned to the original purchaser at CMC's expenses). Under no circumstances shall CMC be responsible for loss of use and/or for any direct, incidental and/or consequential damages.

The foregoing warranty is the only responsibility of CMC and is in lieu of all other warranties whether expressed or implied.

103C-04	302
MODEL NO	SERIAL NO
J. de Chevigny	19-06-81
INSPECTED BY	WARRANTY DATE

This Electronic Instrument was thoroughly inspected and performance tested prior to shipment; if received in damaged condition, please file a claim with the carrier and advise Canadian Marconi Company, Electronic Instruments Service Dept. of the damages.

If necessary to return unit
for service, ship to:

CANADIAN MARCONI COMPANY,
ELECTRONIC INSTRUMENTS SERVICE DEPT.
320 Aberdare Road
Door 10
MONTREAL, QUEBEC.

TELEPHONE (514) 341-7630 Ext. 560

FM control to the point where an indication of 100.0 kHz is obtained on the external modulation meter (30 Hz to 15 kHz bandwidth).

e. Adjust potentiometer R5 on modulation printed circuit board A41 as required to produce an indication of 100, exactly, on the signal generator MODULATION meter.

f. Depress the FM OFF and AM INT switches. Set the METER switch to 100% AM. Set the external modulation meter to its AM mode (100% full scale). Advance the AM control on the signal generator to the point where an indication of 50.0% is obtained on the external modulation meter.

g. Adjust potentiometer R28 on meter printed circuit board A3 as required to produce an indication of 50, exactly, on the signal generator MODULATION meter.

h. Adjust the OUTPUT control of the signal generator to the setting that produces an indication of -10 dB on the OUTPUT LEVEL meter.

i. Adjust potentiometer R34 on meter printed circuit board A3 as required to produce an indication of 50.0% on the external modulation meter.

j. Using the signal generator OUTPUT control, set the OUTPUT LEVEL meter to 0 dB. Note the indication on the external modulation meter. If the meter indication has changed from 50.0%, repeat steps f through j.

4-24. Sweep Oscillator Adjustments. Proceed as follows:

a. Set the signal generator controls as follows:

Control	Position
RESOLUTION Hz switch	1
FM INT switch	Depressed
AM OFF switch	Depressed
DEVIATION kHz switch	300
MOD FREQ kHz switch	Line Hz RAMP
METER switch	FM
SWEEP switch	ON
FREQUENCY MHz switch	~~.25 - .5~~ .125 - .25
VERNIER control	.262 MHz on output frequency indicator
RF switch	ON
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
FM control	Fully counterclockwise

b. Connect a coaxial cable from the OUT (BNC) connector on the front panel of the signal generator to the COUNTER EXT connector. Press the COUNTER EXT switch. Remove the line sync lead to connector A41P6 on modulation printed circuit board A41 being careful that lead is not allowed to short to any other circuitry or ground. Adjust potentiometer R12 on modulation printed circuit board A41 as required to obtain a frequency indication of 60 Hz or 50 Hz, depending on the line frequency, on the output frequency indicator. Set the resolution Hz switch to 1000. Reconnect the line sync lead to connector A41P6.

c. Depress the COUNTER INT and FM INT switches. Connect spectrum analyzer, Hewlett Packard Model 140T/8552B/8554B, to the signal generator OUTPUT connector. Set the MOD FREQ kHz switch to 0.4. Adjust the scan width of the spectrum analyzer to 10 kHz/division, and center the 262 kHz signal on the spectrum analyzer screen.

d. Advance the FM control of the signal generator to produce a 30 indication on the lower scale of the signal generator MODULATION meter.

e. Adjust potentiometer R13 on meter printed circuit board A3 as required to produce a peak-to-peak deviation of 60 kHz as observed on the spectrum analyzer display.

f. Set the FREQUENCY MHz switch to band 2 (0.25 - 0.5). Rotate the FM control fully counterclockwise, and adjust the VERNIER control as required to produce a frequency indication of 0.455 MHz on the output frequency indicator. Retune the spectrum analyzer to center the output signal on the display.

g. Advance the FM control setting to produce an indication of 30 on the lower scale of the MODULATION meter.

h. Adjust potentiometer R12 on meter printed circuit board A3 as required to produce a peak-to-peak deviation of 60 kHz on the spectrum analyzer display.

i. Set the FREQUENCY MHz switch to band 4 (1-2). Turn the FM control fully counterclockwise. Adjust the VERNIER control as required to produce an indication of 1.200 MHz on the output frequency indicator. Tune the spectrum analyzer to center the signal on the display with a scan width of 50 kHz/division.

j. Advance the FM control setting to produce an indication of 100 on the upper scale of the MODULATION meter.

k. Adjust potentiometer R11 on meter printed circuit board A3 as required to produce a peak-to-peak deviation of 200 kHz on the spectrum analyzer display.

l. Set the FREQUENCY MHz switch to band 7 (8-16). Turn the FM control fully counterclockwise. Adjust the VERNIER control as required to produce an indication of 10.700 MHz on the output frequency indicator. Tune the spectrum analyzer to center the signal on the display with a scan width of 0.5 MHz/division.

m. Turn the FM control to produce an indication of 100 on the upper scale of the MODULATION meter.

n. Adjust potentiometer R10 on meter printed circuit board A3 as required to produce a peak-to-peak deviation of 2.0 MHz on the spectrum analyzer display.

o. Set the FREQUENCY MHz switch to band 10 (64-138). Turn the FM control fully counterclockwise. Adjust the VERNIER control as required to obtain an indication of 98.0 MHz on the output frequency indicator. Tune the spectrum analyzer to center the signal on the display with a scan width of 5 MHz/division.

p. Advance the FM control setting to produce an indication of 100 on the upper scale of the MODULATION meter.

q. Adjust potentiometer R9 on meter printed circuit board A3 as required to produce a peak-to-peak deviation of 20 MHz on the spectrum analyzer display.

4-25. **Ramp Generator Frequency Adjustment.** The ramp frequency is synchronized to the power line frequency. To adjust the ramp frequency, proceed as follows:

a. Connect the ramp signal at the front panel OUT connector to the vertical input of an oscilloscope.

b. Set the signal generator controls as follows:

Control	Position
FM INT switch	Depressed
AM OFF switch	Depressed
MOD FREQ kHz switch	LINE Hz RAMP
FREQUENCY MHz switch	8-16
SWEEP switch	ON

c. Set the oscilloscope controls for 1 volt/division vertical sensitivity, 2 ms/major division sweep time, and line synchronization.

d. Adjust potentiometer R12 on modulation printed circuit board A41 for a line synchronized display on the oscilloscope. Adjust the oscilloscope time base for a period of exactly 8.2 major divisions.

e. Set the signal generator POWER switch to OFF. Disconnect the synchronization lead from the lower right side of modulation printed circuit board A41. Set the signal generator POWER switch to ON, and set the oscilloscope synchronization control to INT-NEGATIVE.

f. Readjust potentiometer R12 on modulation printed circuit board A41 for an oscilloscope display period of exactly 8.5 major divisions.

g. Recheck the adjustments of steps d through f.

h. Reconnect the synchronization lead disconnected in step e. The period of the oscilloscope display should change back to 8.2 to 8.4 major divisions.

4-26. **Intensity Marker 10.7 MHz ±300 kHz Deviation Adjustment.** Proceed as follows:

a. Set the signal generator controls as follows:

Control	Position
METER switch	FM
DEVIATION kHz switch	100
FM INT switch	Depressed
AM OFF switch	Depressed
MOD FREQ kHz switch	LINE Hz RAMP
FM control	Indication of 30 on MODULATION meter scale
FREQUENCY MHz switch	8-16
SWEEP switch	ON (adjust frequency to 10.7 MHz with VERNIER control
SWEEP switch	MARKER (adjust marker frequency to 10.7 MHz with TUNING control)

b. Connect the oscilloscope vertical input connector to pin 1 of integrated circuit IC4 on intensity marker printed circuit board A6. Adjust potentiometer R28 on intensity marker printed circuit board A6 for an oscilloscope display ~~period~~ of 650 microseconds.

c. Using the oscilloscope dual trace, connect one channel of the oscilloscope to the INTENSITY MARKER OUT connector on the rear panel of the signal generator, and connect

the second oscilloscope channel to test point TP2 on intensity marker printed circuit board A6. Adjust the oscilloscope time base, line synchronized, for one ramp period. Observe the position of the marker pulse with respect to mixer zero; they should occur at the same time. (See figure 4-3.) If necessary, adjust potentiometer R21 on intensity marker printed circuit board A6, using the X10 horizontal amplification on the oscilloscope, to position the marker at the mixer zero position.

d. Using the signal generator TUNING control, position the intensity marker 10% from each sweep end, as indicated by displays of 10.430 MHz and 10.970 MHz on the output frequency indicator. At each of these TUNING control settings, observe the marker pulse position relative to the mixer zero beat, using the X10 amplification setting of the oscilloscope. The marker pulse position should not be displaced from the mixer zero position by more than 0.5% of the sweep width. If necessary, readjust potentiometer R21 on intensity marker printed circuit board A6 to obtain the proper marker pulse position.

e. Using the signal generator TUNING control, position the intensity marker to the center of the sweep. Observe the full ramp period on the oscilloscope. There should be no additional markers in the center 80% of the display. If additional markers are observed, further adjustment of potentiometers R28 and R21 on intensity marker printed circuit board A6 may be required.

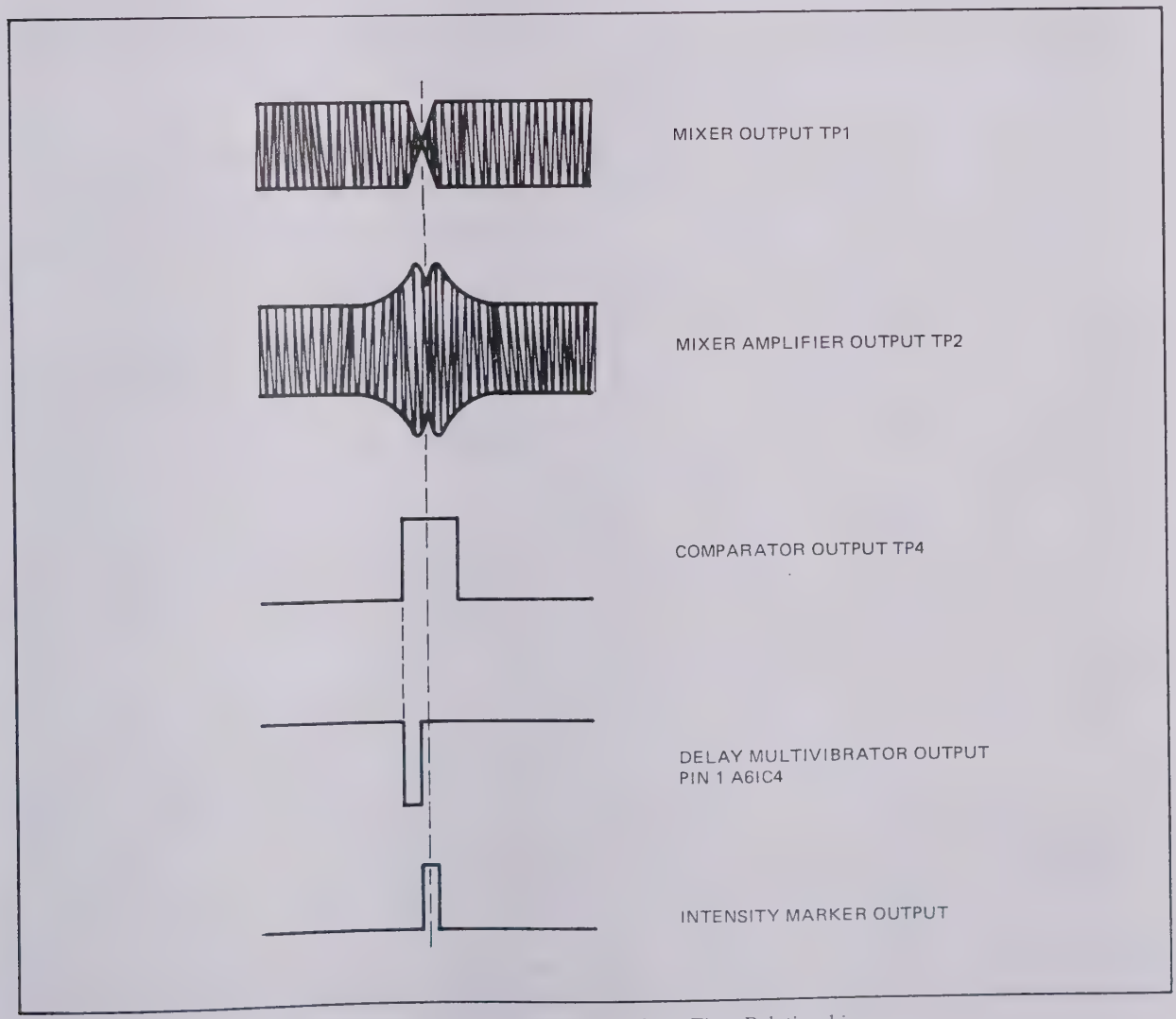


Figure 4-3. Intensity Marker Waveform Time Relationships

4-27. **Intensity Marker 10.7 MHz ±1 MHz Deviation Adjustment.** Proceed as follows:

a. Set the signal generator controls as follows:

Control	Position
METER switch	FM
DEVIATION kHz switch	300
FM INT switch	Depressed
AM OFF switch	Depressed
MOD FREQ kHz switch	LINE Hz RAMP
FM control	Indication of 10 on MODULATION meter scale
FREQUENCY MHz switch	8-16
SWEEP switch	ON (adjust frequency to 10.7 MHz with VERNIER control)
SWEEP switch	MARKER (adjust marker frequency to 10.7 MHz with TUNING control)

b. Connect the oscilloscope vertical input to pin 1 of integrated circuit IC4 on intensity marker printed circuit board A6. Adjust potentiometer R30 on intensity marker printed circuit board A6 for an oscilloscope display period of 160 microseconds.

c. Using the oscilloscope dual trace, connect one channel of the oscilloscope to the INTENSITY MARKER OUT connector on the rear panel of the signal generator, and connect the second oscilloscope channel to test point TP2 on intensity marker printed circuit board A6. Adjust the oscilloscope time base, line synchronized, for one ramp period. Observe the position of the marker pulse with respect to mixer zero; they should occur at the same time. (See figure 4-3.) If necessary, adjust potentiometer R23 on intensity marker printed circuit board A6 to position the marker at the mixer zero position using the X10 horizontal amplification on the oscilloscope.

d. Using the signal generator TUNING control, position the intensity marker 10% from each sweep end, as indicated by displays of 9.8 MHz and 11.6 MHz on the output frequency indicator. At each of these TUNING control settings, observe the marker pulse position relative to the mixer position, using the X10 amplification setting of the oscilloscope. The marker pulse position should not be displaced from the mixer zero position by more than 0.5% of the sweep width. If necessary, readjust potentiometer R23 on intensity marker printed circuit board A6 to obtain the proper marker pulse position.

e. Using the signal generator TUNING control, position the intensity marker to the center of the sweep. Observe the full ramp period on the oscilloscope. There should be no additional markers in the center 80% of the display. If additional markers are observed, further adjustment of potentiometers R30 and R23 on intensity marker printed circuit board A6 may be required.

4-28. **Intensity Marker 98 MHz ±10 MHz Deviation Adjustment.** Proceed as follows:

a. Set the signal generator controls as follows:

Control	Position
METER switch	FM
DEVIATION kHz switch	300
FM INT switch	Depressed
AM OFF switch	Depressed
MOD FREQ kHz switch	LINE Hz RAMP
FM control	Indication of 10 on MODULATION meter scale
FREQUENCY MHz switch	64-138
SWEEP switch	ON (adjust frequency to 98.0 MHz with VERNIER control)
SWEEP switch	MARKER (adjust marker frequency to 98.0 MHz with TUNING control)

b. Connect the oscilloscope vertical input to pin 1 of integrated circuit IC4 on intensity marker printed circuit board A6. Adjust potentiometer R31 on intensity marker printed circuit board A6 for an oscilloscope display period of 20 microseconds.

c. Using the oscilloscope dual trace, connect one channel of the oscilloscope to the INTENSITY MARKER OUT connector on the rear panel of the signal generator, and connect the second channel to test point TP2 on intensity marker printed circuit board A6. Adjust the oscilloscope time base, line synchronized, for one ramp period. Observe the position of the marker pulse with respect to mixer zero; they should occur at the same time. (See figure 4-3.) If necessary, adjust potentiometer R27 on intensity marker printed circuit board A6 to position the marker at the mixer zero position using the X10 horizontal amplification on the oscilloscope.

d. Using the signal generator TUNING control, position the intensity marker 10% from each sweep end, as indicated by displays of 89.0 MHz and 107.0 MHz on the output frequency indicator. At each of these TUNING control settings, observe the marker pulse position relative to the mixer zero position, using the X10 amplification setting of the oscilloscope. The marker pulse position should not be displaced from the mixer zero position by more than 0.25% of the sweep width. If necessary, readjust potentiometer R27 on intensity marker printed circuit board A6 to obtain the proper marker pulse position.

e. Using the signal generator TUNING control, position the intensity marker to the center of the sweep. Observe the full ramp period on the oscilloscope. There should be no additional markers in the center 80% of the display. If additional markers are observed, further adjustment of potentiometers R31 and R27 on intensity marker printed circuit board A6 may be required.

4-29. PARTS REMOVAL.

4-30. General. Careful attention has been paid in the design of the signal generator to maintainability. Most parts are readily accessible for checking and replacement when the case and cover shields are removed. Solid-state circuit components, mounted on printed circuit boards, are used throughout the signal generator. Standard printed circuit board maintenance techniques are required for removal and replacement of parts. Excessive heat must be avoided; a low-wattage soldering iron and suitable heat sinks should be used for all soldering and unsoldering operations.

4-31. VFO Inductuner Removal. (See figures 4-1 and 4-2.) Inductuner L1901 is mounted inside the VFO housing. To remove the inductuner, proceed as follows:

a. Remove the shield covers from the top and bottom of the VFO housing.

b. Unsolder all lead wires from the inductuner.

c. Loosen the setscrews that attach the flexible coupling to the shaft of the inductuner.

d. Remove the three screws that attach the inductuner to the chassis.

e. Press back the flexible coupling from the inductuner shaft until the coupling clears the end of the shaft, and lift the inductuner out of the VFO housing.

4-32. Tuning Control Drive, Dial Cord Replacement. The TUNING control drives the VFO tuning elements by means of a dial cord arrangement. If replacement of the dial cord becomes necessary, set the TUNING control fully counterclockwise against the stop and install the dial cord as shown in figure 4-4. Use 0.028-inch diameter nylon dial cord, General Cement part number 75, or equivalent.

4-33. Varactor Tracking Capacitor, Dial Cord Replacement. Varactor tracking capacitor C1913 is driven from the VFO inductuner drive shaft by means of a dial cord arrangement. If replacement of the dial cord becomes necessary, proceed as follows:

a. Set the TUNING control to the middle of its tuning range.

b. Remove the shield covers from the top and bottom of the VFO housing.

c. Position the pulley on the shaft of capacitor C1913 so that the slot in the pulley faces directly downward.

d. Install the replacement dial cord as shown in figure 4-5. Use 0.028-inch diameter nylon dial cord, General Cement part number 75, or equivalent.

e. Turn the TUNING control fully counterclockwise against the end stop. Verify that the rotor plates of capacitor C1913 are 1/16 inch from full mesh. If necessary, loosen the setscrews in the capacitor drive pulley and rotate the capacitor shaft to achieve the specified degree of mesh; then, tighten the setscrews.

f. Check FM tracking and VFO alignment in accordance with paragraph 4-20.

4-34. INDUCTUNER CLEANING AND LUBRICATION.

4-35. To clean and lubricate inductuner L1901, proceed as follows:

a. Straighten the twist tabs and remove the top cover from the inductuner.

b. Rotate the TUNING control fully counterclockwise against the end stop. Note which turn of the spiral element is engaged by the sliding contact of the inductuner.

c. Carefully lift the contact arm off the spiral element and swing the contact arm out toward the top of the inductuner.

CAUTION

Do not lift the contact arm any higher than necessary; otherwise, contact pressure will be lost.

d. Clean the spiral element, the sliding contact arm, and the ground wiper contact of the inductuner thoroughly with a suitable degreaser, such as Freon spray degreaser or Chlorothene-NU. Take particular care to clean under the saddle-shaped contact where it slides on the spiral element.

e. Ascertain that the TUNING control is still set against the counterclockwise stop. Replace the contact arm on the same turn on the spiral element as noted in step b.

f. Lubricate the spiral element, the sliding contact arm, and the ground wiper contact *sparingly* with Anderol No. 795 contact grease.

g. Replace the top cover of the inductuner, and twist the tabs to secure.

4-36. VOLTAGE MEASUREMENTS.

4-37. Tables 4-12 through 4-25 list typical DC voltages at the terminals of transistors and integrated circuits. All voltage measurements were made using a Weston Model 1240 voltmeter. Unless otherwise noted, all voltages are positive, and are measured with reference to chassis ground.

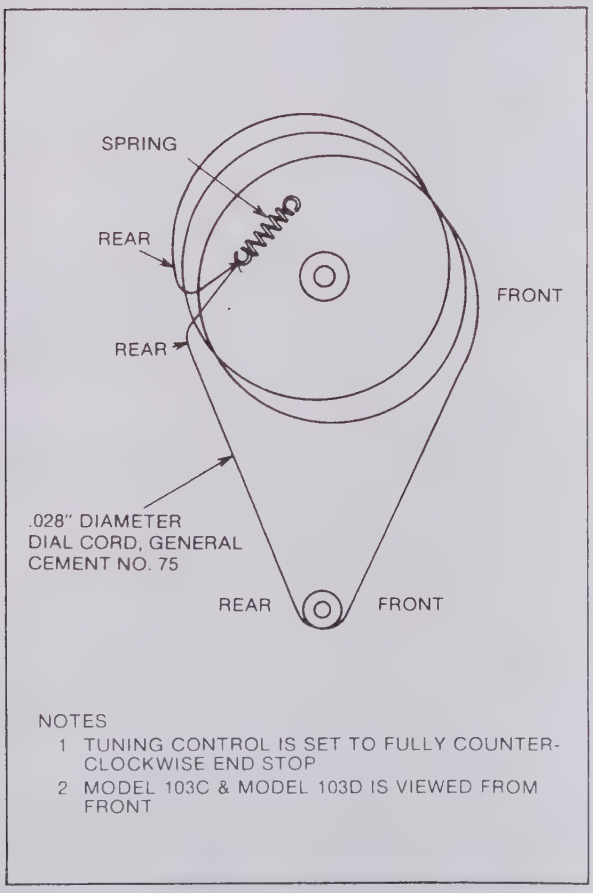


Figure 4-4. TUNING Control Drive, Dial Cord Installation

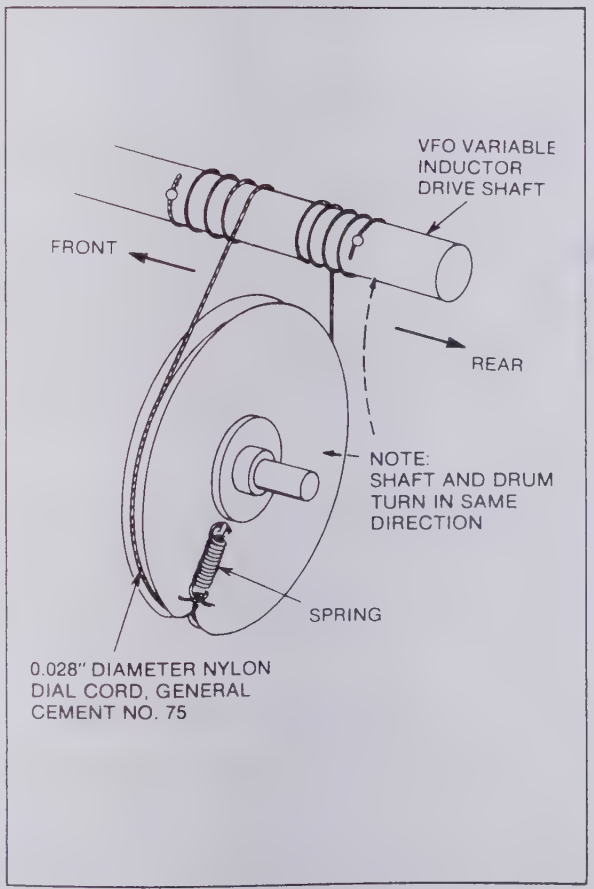


Figure 4-5. Varactor Tracking Capacitor, Dial Cord Installation

TABLE 4-12. DC VOLTAGES, DISPLAY PCB A2

Component	Terminal Voltage											
	E	B	C	1	2	3	5	8	9	11	12	14
Q1	0	0.65	0.9									
Q2	2	1	0.9									
IC1				0.7	0.5	0.5	5	0.6	1.7	0.3	0.7	0.8
IC2				1.9	0.5	0.5	5	1.7	1.7	0.4	1.9	0.3
IC3				1.8	0.5	0.5	5	1.8	1.8	0.4	1.8	0.4
IC4				1.9	0.5	0.5	5	0.7	0.6	1.5	2	0.4
IC5				2	0.5	0.5	5	0.7	0.7	1.5	2	1.5
IC6				0.2	0.5	0.5	5	0.1	0.1	1.2	0.2	1.5

TABLE 4-13. DC VOLTAGES, METER PCB A3

Component	Terminal Voltage*					
	2	3	4	5	6	7
A1		0	-15		0.84	15
A2	-1.6	-1.6	-15	12.9	4.1	15

*All voltages obtained with OUTPUT LEVEL attenuator set to +10 dBm and OUTPUT LEVEL meter indicating 0 dB.

TABLE 4-14. DC VOLTAGES, INTENSITY MARKER PCB A6

Component	Terminal Voltage*																	
	E	B	C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Q1	4.8	5.6	9.8																
Q2	0	0.7	0.1																
Q3	-5.2	-4.8	12.6																
Q4	0	0.6	13.1																
Q5	0	0.7	0																
Q6	-5.2	-4.8	12.7																
IC1				0	4.8	0.5	0.9	4.8	0	0	0	0	9.5	13.6	0	0	0	0	15
IC2				0	4.8	-0.1	-0.2	0	0	0	0	13.6	9.8	13.6	0.2	0	0.1	0	0.1
IC3				0	4.8	-0.1	-0.2	4.8	0	-3.1	0	13.6	9.9	13.5	4.3	4.2	1.9	4.8	15
IC4				0	-0.3	0	0	4.8	3.3	0	0.2	0	0.7	0.6	0	1.3	4.8		
IC5				3.6	-0.2	0	0	0	0.1	0	-0.4	0.7	4.8	0.7	-0.3	-0.3	4.8		
A1				0.1	0	0	-15	0.1	0.1	15	1.2								
A2				-12.9	2.8	0.1	-15	-13.6	14.2	15	14.3								

*All voltages obtained using 98 MHz sweep, 100 MHz deviation.

TABLE 4-15. DC VOLTAGES, OUTPUT PCB A7

Component	Terminal Voltage 1	2	3	4	5	6	7	8
A1	12	-0.5	-0.5	-15	12	2.1	14.9	-13.8
A2	14.8	0.1	-1.0	-15	-14.6	-1.0	14.9	14.8

TABLE 4-16. DC VOLTAGES, DRIVER PCB A8

Component	Terminal Voltage* E	B	C	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Q1	7.4	1.4	15														
Q2	4.1	4.8	10.5														
Q3	1.9	2.6	4.5														
Q4	4.6	5.3	9.8														
Q5	4.2	4.7	9.8														
Q6	3.9	4.6	10.2														
IC1				4.7		3.6		1.4		0	0	0	0.8		0.8	0	4.7
IC2				4.7		3.6		1.4		0	0	0	0.8		0.8	0	4.7
IC3				4.7		3.6		1.3		0	0	0	1.5		1.5	0	4.7
IC4				4.7		3.5		1.4		0	0	0	1.5		1.5	0	4.7
IC5				4.8		3.6		1.4		0	0	0	1.5		1.5	0	4.8

*All voltages obtained with an output frequency of 150 MHz, 0 dBm output level, and no modulation; IC measurements obtained with appropriate sweep engaged.

TABLE 4-17. DC VOLTAGES, PRESCALER PCB A10

Component	Terminal Voltage* G	D	S	E	B	C	1	2	3	4	5	6	7	9	10	11	12	13	14	15	16
Q1	4.6	5.3	14.9																		
Q2				4.7	5.4	14.9															
IC1							4.7	3.5	3.5	3.5	3.5	3.5	3.5	3.4	3.4	3.5	3.5	3.5	3.5	3.5	4.7
IC2							4.7	3.6	3.8	3.5	0	3.5	4.1	3.3	3.4	3.3	0	0	3.8	4.1	4.7
IC4							4.7	3.6	3.5	0	0	3.5	3.6	0	3.5	3.5	0	0	3.5	3.5	4.7
IC6							4.7	4.1	3.6	0	0	0	3.6	3.5	3.6	0	0	0	3.6	3.6	4.7

*All voltages obtained with no modulation, output frequency of 100 MHz, and RESOLUTION Hz switch set to 1k.

TABLE 4-18. DC VOLTAGES, PHASE LOCK DIVIDER PCB A11

	Terminal Voltage*															
Component	E	B	C	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Q1	1.8	2.5	6.7														
Q2	5.8	6.7	9.0														
IC1				0	-5.1	1.1	0	-5.1	-1.5	0.2	0						
IC2				1.6	1.3	1.2	1.6	1.2	1.3	0	1.5	1.5	1.5	1.2	1.5	1.6	4.8

*All voltages obtained with an output frequency of 100 MHz and phase lock on.

TABLE 4-19. DC VOLTAGES, FREQUENCY DIVIDER PCB A13

	Terminal Voltage														
Component	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IC1	0	-1.2	-0.6	-1.7	-0.6	-5.1	-5.1	-5.1	-1.2	-0.2	-0.2	-1.1	-5.1	-1.6	-1.2
IC2	0	-1.1	-1.7	-1.7	-1.6	-5	-0.7	-5.1	-1.3	-0.7	-0.6	-1.1	-2.6	-1.1	-1.4
IC3	0	-0.7	-1.8	-5	-5	-1.6	-1.8	-5.1	-0.2	-0.7	-1.7	-4.7	-4.7	-0.7	-1.7
IC4	0	-1.2	-0.6	-1.7	-0.6	-5.1	-5.1	-5.1	-1.7	-5.1	-5.1	-1.7	-5.1	-0.6	-0.8
IC5	0	0	0	-0.8	-4	-4.2	-0.8	-5.1	-0.8	-0.8	0	-5.1	-0.8	0	0
IC6	0	0	0	-0.8	-4.8	-4.6	-0.8	-0.8	-5.1	-0.8	0	-4.4	-0.8	0	0
IC7	-1.7	-5.1	-5	-0.8	-5	-5	-5.1	-5	-5	-0.8	-5	-5.1	-1.7	0	

TABLE 4-20. DC VOLTAGES, POWER SUPPLY PCB A14

	Terminal Voltage									
Component	IN	OUT	CONTROL	1	2	3	4	6	7	8
IC1	22.7	15.1	9.5							
IC2	7.14	0	-5							
IC3	12.7	5	0							
IC4	0	-5.1	-11.8							
A1				-14	6.3	6.3	-15	9.5	15	9.3
A2				-14	0	0	-15	-4.9	15	-5

TABLE 4-21. DC VOLTAGES, DISPLAY TIME BASE PCB A16

	Terminal Voltage*															
Component	E	B	C	1	2	3	4	5	6	8	9	10	11	12	13	14
Q1	0	0.05	4.7													
IC1						4.7	0.1	0	3.4							5
IC2				1.6				5					0.7	1.5		1.7
IC3				3.4	1.2	3.4	0.8	0.5	3.4	2.7	0.8	5	3.4	1.2	0	5
IC4				2.1	3.3	0.1	3.5	3.4	3.4	0.8	3.5	3.5	2.3	1.4	3.5	5
IC5				1.6				5					0.7	1.7		0.7
IC6				1.4	5	2.2	1.4	0.5	3.4	3.4	3.4	1.2	3.3	1.2	3.5	5
IC7				1.7				5					0.7	1.7		0.7
IC8				1.7				5					0.8	1.7		0.7
IC9					5	5	5	5	1.7	2	5	5	5	0.8	5	5
IC10				1.7				5					0.8	1.7		0.8
IC11				1.7	0.3	0.8	0.8	0.05				5	0.6	2.8	0.8	5
IC12				3.3				5					3.3	3.3		0.8

*All voltages obtained with COUNTER INT switch depressed and RESOLUTION Hz switch set to 1k. Underscored readings are highest readings observed.

TABLE 4-22. DC VOLTAGES, MODULATION PCB A41

	Terminal Voltage*															
Component	E	B	C	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Q1	0	0	6.2														
IC2				0	0	6	4.9	13	13	6.2	14.9						
IC3				4.9	4.9	0.1	4.3	4.3	0.1	0	4.3	0.3	0.3	0	1.1	1.1	4.9
A1				-	0	0	15	12.5	0	14.9							
A2						0	15		0	14.9							
A3				-13.6	0	-0.1	-15		-0.1	14.9	-0.6						
A4				0	0	0	-15	14.8	14.8	14.9	14.9						
A5				14.9		0	-15		0	14.9	14.9						
A6					0	0	-14.3	11.5	0	14.3							
A7					0	0	-15		-0.1	14.9							

*All voltages obtained with MOD FREQ kHz switch set to LINE Hz RAMP, FM INT switch depressed, and FM control set to its counterclockwise limit.

TABLE 4-23. DC VOLTAGES, PHASE LOCK TIME BASE PCB

Component	Terminal Voltage													
	E	B	C	1	2	3	4	5	6	9	10	11	12	14
Q1501	0	0.2	0.6											
Q1502	5	4.2	4.4											
IC1501				3.7	1.7	1.2	0.1	0.1	4.4	4.9	4.9			
IC1502				0.4				5				0.5	1.5	0.5
IC1503				1.5				5				0.7	1.7	0.7
IC1504				1.7				5				0.7	1.7	0.7
IC1505				1.7				5				0.7	1.8	0.7
IC1506				1.9				5				0.8	1.9	1.8

TABLE 4-24. DC VOLTAGES, PHASE DETECTOR PCB

Component	Terminal Voltage																	
	G	D	S	E	B	C	1	2	3	4	5	6	7	8	9	11	12	13
Q1601				0.06	0	-12												
Q1602				0	0.1	11												
Q1603				0	0.1	11												
Q1604	-14.4	-0.01	0.1															
Q1605				4.1	4.8	5												
A1601							-13.6	4.7	4.2	-15		0	15	-0.6				
A1602							-13.1	7.4	0.2	-15		-1	15	-0.7				
A1603							-13.2	0.2	-7.4	-15		-0.5	15	-0.6				
A1604							-13.6	0	0	-15		0.2	15	-0.3				
A1605							-13.1	7.4	0.2	-15		-1	15	-0.7				
A1606								15	-8	-15		-4	-4					
IC1601							4		1.9		0.1	3.8		3.6	0.1	3.7		3.9
IC1602							4	0.1	0.1	0.1	3.6	3.8						
IC1603							-0.5	3	3.6	0.8	0.8	3				3.3	3	-1
IC1604							0	3.5	0.1	0.1	0.1	4.8					0.1	3.7

TABLE 4-25. DC VOLTAGES, PHASE LOCK COUNTER PCB

Component	Terminal Voltage*														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IC1701	4.1		3.7			0.1									
IC1702	4.9	4.9	3.7	3.7	3.7	3.7		0.1	0.1	0.1	3.8	4.9	4.9		
IC1703	1.7	1.7	1.6	0.2	1.5	1.5		3.8			0.2	1.7			
IC1704	1.9	4.8	4.8	4.8	4.8	0.1	0	4.1			0.2		1.5	5	
IC1705	0.1	1.3	3.5	0.1	1.3	3.5		3.5	1.3	0.1	3.5	1.2	0.2		
IC1706	0.1	2	3.7	0.1	5	3.7	3.7	3.7			3.7		0.1	3.7	
IC1707	3.5	1.3	0.1	3.7	3.7	3.7	3.3		3.6	0.2	3.7	3.6	3.6	2	0.2
IC1708	0.1	1.9		1.9	1.9	3.5		3.7	0.1	1.9		4.1	1.9		
IC1709	3.7	2	2	0.1	5	2	2	0.1			0.1		0.1	0.1	
IC1710	3.5	1.3	3.7	0.1	0.1	0.1	3.3		3.6	0.2	2	2	2	2	
IC1711		2	1.2		3.8			2			1.3	2			
IC1712	3.7	2	2	0.1	5	2	2	3.6			3.7		0.1	3.7	
IC1713	3.6	1.3	0.1	3.7	3.7	0.1	0.3		3.7	0.4	2	2	2	2	0.2
IC1714	3.7	2	2	0.1	5	2	2	3.7			0.1		0.1	3.7	
IC1715	3.5	1.3	0.1	0.1	0.1	0.1	0.3				2	2	2	2	0.3
IC1716	1.3	1.7	1.7	1.3	1.7	1.7					1.7	1.7	1.3		
IC1717	0.1	1.5	1.5	0.1	5	1.5					3.7		0.1	3.7	
IC1718	3.5	1.3	0.1	0.1	0.1	0.1	1.6		3.7	1.6	1.7	1.7	1.7	1.6	0.4

*All voltages obtained with phase lock on at an output frequency of 100 MHz.

SECTION V
PARTS LIST

TABLE OF REPLACEABLE PARTS

Reference	Description			BEC Part No.
	SUB PANEL (A1)			
C1 through C4	Not Used			
C5	Capacitor, Tant.	100 μF 20% 10V	Sprague 196D107X0010LA3	283291
C6 through C8	Capacitor, Cer.	0.01 μF 100V	Erie 805-000X5V0103Z	224119
C11	Capacitor, Tant.	100 μF 20% 10V	Sprague 196D107X0010LA3	283291
CR1	Diode, Sil.	1N914	T.I.	530058
CR2	Not Used			
CR3	Lamp, Solid State	RL-4484	Litronix	536013
CR4*	Lamp, Solid State	MV5025	Monsanto	536000
J1	Not Used			
J2	Connector, BNC		Dage 081-1	479123
J3	Connector	15 Pin	Amphenol 143-015-01	479297
J4	Connector, BNC		Dage 081-1	479123
J5	Connector, BNC		Dage 081-1	479123
J12, J13	Adapter	TNC to N	Gremar 6098-Z	481009
M1	Meter & Scale, Mod.		Ammon	554272
M1	Meter & Scale, Mod.	(Alternate)	Hoyt	554310
M2	Meter & Scale, RF		Ammon	554320
M2	Meter & Scale, RF	(Alternate)	Hoyt	554316
R1	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R2 through R11	Not Used			
R12	Resistor, MF	4.12 kΩ 1%	RN55	341459
R13	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R14	Resistor, MF	634 Ω 1%	RN55	341277
R15	Resistor, MF	10.0 kΩ 1%	RN55	341400
R16	Resistor, Var.	10 kΩ 10% 1W	AB70A1N116P103U	311390
R17 through R22	Not Used			
R23	Resistor, MF	10.0 kΩ 1%	RN55	341400
R24 through R26	Not Used			
R27	Resistor, Var.	10 kΩ 10% 1W	AB70A1N116P103U	311390
R28	Resistor, MF	10.0 kΩ 1%	RN55	341400
R29	Resistor, MF	634 Ω 1%	RN55	341277
R30 through R35	Not Used			
R36	Resistor, Comp.	1.5 kΩ 5%	AB-CB	343317
R37	Not Used			
R38	Resistor, Comp.	150 Ω 5%	AB-CB	343217
R39	Not Used			
R40	Not Used			
R41	Resistor, Var. Dual	50 Ω/1 kΩ 10%		311387
R42	Resistor, Var.	2 kΩ 10% 1W	AB70A1N116P202U	311388
R43*	Resistor, Var.	500 Ω 10% 1W	AB70A1N116P501U	311356
R44	Resistor, MF	3.92 kΩ 1%	RN55	341357
R45	Resistor, MF	4.87 kΩ 1%	RN55	341366
R46	Resistor, Comp.	82 kΩ 5%	AB-CB	343422

*Model 103D Only

Reference	Description			BEC Part No.
S1	Not Used			
S2	Switch, Rocker	2P2T	UIS RSW-04-22-SD-BB-S-W1-BK	465203
S3	Not Used			
S4	Switch, Rocker	Modified	UID 02-469-0005	465185
S5	Switch, Push Button	Int-Ext	Centralab PB-10	465206
S6	Not Used			
S7	Not Used			
S8	Switch, Slide		Continental Wirt G-168-S	465208
S9	Switch, Push Button	Counter	Centralab PB15	465209
S10	Switch, Push Button	Resolution	Ledex 212	466247
S11	Switch, Micro	VFO	Unimax 2TMA15-1	465000
S12	Switch, Slide	RF	Continental Wirt G-168-S	465208
S13	Not Used			
S14*	Switch, Push Button	Modified	Centralab PB-10	465221
FL101	RFI Filter Ass'y.		Boonton Electronics	439003
FL102	RFI Filter Ass'y.		Boonton Electronics	439003
FL103	RFI Filter Ass'y.	7 (V10)	Boonton Electronics	103126-1
J101	Connector, SMA		Specialty 39 JR117-1	479328
	DEVIATION SWITCH (A1)			
CR1	Diode, Sil.	1N914	T.I.	530058
R17	Resistor, MF	1.15 kΩ 1%	RN55	341306
R18	Resistor, MF	1.15 kΩ 1%	RN55	341306
R19	Resistor, MF	750 Ω 1%	RN55	341284
R20	Resistor, MF	750 Ω 1%	RN55	341284
R21	Resistor, MF	1.15 kΩ 1%	RN55	341306
R22	Resistor, MF	1.15 kΩ 1%	RN55	341306
R23	Not Used			
R24	Resistor, MF	845 Ω 1%	RN55	341289
R25	Resistor, MF	3.01 kΩ 1%	RN55	341346
R26	Resistor, MF	845 Ω 1%	RN55	341289
S6	Switch, Rotary	6P 5 Pos., 4 D	Ledex 212	466246
	MODULATION SWITCH (A1)			
C3	Capacitor, Mica	3100 pF 0.5% 500V	G.I. RDM19-FD312E03	200521
C4	Capacitor, Mica	3100 pF 0.5% 500V	G.I. RDM19-FD312E03	200521
R1	Not Used			
R2	Resistor, MF	127 kΩ 1%	RN55	341510
R3	Resistor, MF	51.1 kΩ 1%	RN55	341468
R4	Resistor, MF	16.9 kΩ 1%	RN55	341422
R5	Resistor, MF	5.11 kΩ 1%	RN55	341368
R6	Resistor, MF	2.67 kΩ 1%	RN55	341341
R7	Resistor, MF	127 kΩ 1%	RN55	341510
R8	Resistor, MF	51.1 kΩ 1%	RN55	341468
R9	Resistor, MF	16.9 kΩ 1%	RN55	341422
R10	Resistor, MF	5.11 kΩ 1%	RN55	341368
R11	Resistor, MF	2.67 kΩ 1%	RN55	341341
S3	Switch, Rotary	4P 6 Pos. 3 D	Ledex 212	466245
	BAND SWITCH, FRONT (A1)			
R30	Resistor, MF	2.37 kΩ 1%	RN55	341336
R31	Resistor, MF	768 Ω 1%	RN55	341285
R32	Resistor, MF	768 Ω 1%	RN55	341285

*Model 103D Only

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description			BEC Part No.
BAND SWITCH, FRONT (A1)				
R33	Resistor, MF	1.13 kΩ 1%	RN55	341305
R34	Resistor, MF	1.0 kΩ 1%	RN55	341300
R35	Resistor, MF	1.0 kΩ 1%	RN55	341300
R36	Not Used			
R37	Resistor, MF	453 Ω 1%	RN55	341263
R38	Not Used			
R39	Resistor, MF	1.82 kΩ 1%	RN55	341325
R40	Resistor, MF	1.82 kΩ 1%	RN55	341325
S7	Switch, Rotary	5P 11 Pos. 5D	Ledex 312	466244
REAR PANEL				
C1	Capacitor, Cer	0.02 μF 20% 1000V	Erie 841.000 Z5V 203Z	224118
C2	Capacitor, Cer.	0.02 μF 20% 1000V	Erie 841.000 Z5V 203Z	224118
C9	Capacitor, Cer.	0.02 μF 20% 1000V	Erie 841.000 Z5V 203Z	224118
C10	Capacitor, Cer.	0.02 μF 20% 1000V	Erie 841.000 Z5V-203Z	224118
F1	Fuse, Slo Blo	3/4 A 115V	Bussman	545533
F1	Fuse, Slo Blo	3/8 A 230V	Bussman	545532
J8*	Connector	BNC	Dage 081 1	479123
L1	Choke, RF	5.6 μH 10%	Jeffers 4422 1K	400351
L2	Choke, RF	5.6 μH 10%	Jeffers 4422 1K	400351
L3	Choke, RF	22 μH 10%	Jeffers 4424 1K	400350
L4	Choke, RF	22 μH 10%	Jeffers 4424 1K	400350
P1	Connector, Line Cord		Belden 17252	477281
S1	Switch, Rotary	3P 4 Pos 1D	Ledex 210	466230
S15*	Switch	S P S.T.	Carling 1108-62	465106
T1	Transformer, Power		Boonton Electronics	446083
BAND SWITCH (RF) REAR				
C1	Capacitor, Mica	360 pF 5% 50V	Elmenco DM5 FY361J	205027
CR1	Diode, Sil.	1N914	T.I.	530058
CR2	Diode, Sil.	1N914	T.I	530058
S1	Switch, Rotary	6P 11 Pos. 6D	Ledex Series 312	466251
FRAME ASSEMBLY				
P1	Connector, SMA		Specialty 39P125 1	477290
P2	Connector, SMA		Specialty 39P125-1	477290
P3	Connector, SMA		Specialty 39P125-1	477290
P9	Connector, TNC		Specialty 24P104-2	477292
P10	Connector, TNC		Solitron Microwave 4000-0010	477277
P11	Connector, TNC		Solitron Microwave 4000-0010	477277
P101	Connector, SMA		Specialty 39P125 1	477290
AT1**	Attenuator, Step		ALAN	562000
AT1**	Attenuator, Step		RLC	562002
DISPLAY PC BOARD (A2)				
C1	Capacitor, Cer.	0.1 μF 20% 50V	AVX SR215E104MAA	224268
C2	Capacitor, Tant.	10 μF 20% 25V	Sprague 196D106X0025KA1	283293
C3	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C4	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C5	Not Used			
DS1 through DS6	Numeric Display	5082 7357	H.P.	536806
IC1 through IC6	Integrated Circuit	SN7490N (Counter)	T.I.	534035

*Model 103D Only
**One of the above used

Reference	Description			BEC Part No.
L1	Choke, RF	5.6 μH 10%	Jeffers 4435-1K	400308
Q1	Transistor, NPN	2N3904	Motorola	528071
Q2	Transistor, NPN	2N3904	Motorola	528071
R1	Resistor, MF	825 Ω 1%	RN55	341288
R2	Resistor, MF	121 Ω 1%	RN55	341208
R3	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R4	Not Used			
R5	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R6	Resistor, Comp.	1 kΩ 5%	AB-CB	343300
R7	Resistor, Comp.	1 kΩ 5%	AB-CB	343300
METER PC BOARD (A3)				
A1	Op. Amp.	LM310N (Regulator)	National Semiconductor	535035
A2	Op. Amp	LM318N (Regulator)	National Semiconductor	535031
C1	Capacitor, Tant.	100 μF 20% 20V	Sprague 196D107X0020TE4	283313
C2	Capacitor, Tant.	100 μF 20% 20V	Sprague 196D107X0020TE4	283313
C3	Capacitor, Tant.	100 μF 20% 20V	Sprague 196D107X0020TE4	283313
C4	Capacitor, Tant.	22 μF 10% 25V	Sprague 196D226X9025LA3	283308
C5	Capacitor, Cer.	0.1 μF 20% 50V	AVX SR215E104MAA	224268
C6	Capacitor, Mica	5 pF 10% 300V	Elmenco DM5-CC050K	205000
R1	Resistor, MF	2.67 kΩ 1%	RN55	341341
R2	Resistor, MF	4.32 kΩ 1%	RN55	341361
R3	Resistor, MF	1.0 kΩ 1%	RN55	341300
R4	Resistor, MF	2.15 kΩ 1%	RN55	341332
R5	Resistor, MF	2.15 kΩ 1%	RN55	341332
R6	Resistor, MF	1.0 kΩ 1%	RN55	341300
R7	Resistor, MF	10.0 kΩ 1%	RN55	341400
R8	Resistor, MF	10.0 kΩ 1%	RN55	341400
R9 through R13	Resistor, Var.	500 Ω 10% 1/2W	Beckman 72XWR500	311357
R14	Resistor, MF	3.92 kΩ 1%	RN55	341357
R15 through R19	Resistor, MF	511 Ω 1%	RN55	341268
R20	Resistor, Var.	500 Ω 10% 1/2W	Beckman 72XWR500	311357
R21	Resistor, MF	7.50 kΩ 1%	RN55	341384
R22	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R23	Resistor, Var.	100 Ω 10% 1/2W	Beckman 72XWR100	311306
R24	Resistor, MF	100 Ω 1%	RN55	341200
R25	Resistor, MF	1.10 kΩ 1%	RN55	341304
R26	Resistor, MF	9.09 kΩ 1%	RN55	341392
R27	Resistor, MF	10.0 kΩ 1%	RN55	341400
R28	Resistor, Var.	5 kΩ 10% 1/2W	Beckman 72XWR5K	311307
R29	Resistor, MF	12.1 kΩ 1%	RN55	341408
R30	Resistor, MF	5.11 kΩ 1%	RN55	341368
R31	Resistor, MF	3.65 kΩ 1%	RN55	341354
R32	Resistor, MF	15.0 kΩ 1%	RN55	341417
R33	Resistor, MF	22.1 Ω 1%	RN55	341133
R34	Resistor, Var.	20 Ω 20% 1/2W	Beckman 72XWR20	311397
R35	Resistor, Comp.	100 Ω 5%	AB-CB	343200
BUFFER AMPLIFIER PC BOARD (A4)				
C1	Capacitor, Mica	43 pF 5% 300V	Elmenco DM5-EC430J	205014
C2	Capacitor, Cer.	0.01 μF 10% 100V	AVX SR201C103KAA	224269
C3	Capacitor, Cer.	0.01 μF 10% 100V	AVX SR201C103KAA	224269
C4	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C5	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C6	Capacitor, Mica	82 pF 5% 300V	Elmenco DM5-EC820J	205016
C7	Capacitor, Cer.	0.1 μF 20% 50V	AVX SR215E104MAA	224268
C8	Capacitor, Mica	62 pF 5% 300V	Elmenco DM5-EC620J	205015
L1	Choke, RF	1.8 μH 10%	Jeffers 4425-9K	400298
L2	Choke, RF	2.7 μH 10%	Jeffers 4425-11K	400249
Q1	Transistor, NPN	2N5109	RCA	528073
R1	Resistor, Comp.	680 Ω 5%	AB-CB	342280
R2	Resistor, Comp.	3.0 kΩ 5%	AB-CB	343346
R3	Resistor, Comp.	2.0 kΩ 5%	AB-CB	343329
R4	Resistor, Comp.	15 Ω 5%	AB-CB	343117

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description			BEC Part No.
BUFFER AMPLIFIER PC BOARD (A4)				
R5	Resistor, Comp.	150 Ω 5%	AB-EB	344217
R6	Resistor, Comp.	2.7 Ω 5%	AB-CB	343041
T1	Transformer, RF		Boonton Electronics	410064
RFI HOUSING (A5)				
C1 through C5	Capacitor, Cer.	1 μF 20% 50V	AVX SR305E105MAA	224264
FL1 through FL4	RFI Filter Ass'y.		Erie CSK-20124	439003
FL5	RFI Filter Ass'y.	9 (WHT)	Boonton Electronics	103125-1
FL6	RFI Filter Ass'y.		Erie CSK-20124	439003
FL7	RFI Filter Ass'y.		Erie CSK-20124	439003
FL8	Not Used			
FL9	RFI Filter Ass'y.	7 (VIO)	Boonton Electronics	103126-1
FL10	RFI Filter Ass'y.	6 (BLU)	Boonton Electronics	103127-1
FL11 through FL16	RFI Filter Ass'y.		Erie CSK-20124	439003
INTENSITY MARKER PC BOARD (A6)				
A1	Op. Amp.	LF356P	T.I.	535040
A2	Op. Amp.	LM301AN	National Semiconductor	535012
C1 through C4	Capacitor, Tant.	6.8 μF 10% 35V	Sprague 196D685X9035KA1	283217
C5	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C6	Capacitor, Tant.	10 μF 20% 25V	Sprague 196D106X0025KA1	283293
C7	Capacitor, Mica	62 pF 5% 300V	Elmenco DM5-EC620J	205015
C8	Capacitor, Cer.	1 μF 20% 50V	AVX SR305E105MAA	224264
C9	Capacitor, Cer.	470 pF 10% 200V	Kemet C052K471K2X5CA	224307
C10	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C11	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C12	Capacitor, Cer.	1 μF 20% 50V	AVX SR305E105MAA	224264
C13	Capacitor, Mica	47 pF 5% 300V	Elmenco DM5-EC470J	205018
C14	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C15	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C16	Capacitor, Mica	180 pF 5% 100V	Elmenco DM5-FA181J	205023
C17	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C18	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C19	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C20	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C21	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C22	Capacitor, Mica	33 pF 5% 300V	Elmenco DM5EC330J	205010
C23	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C24	Capacitor, Mylar	0.022 μF 10% 200V	TRW 663 W (ONLY)	234042
C25	Capacitor, Cer.	4700 pF 10% 100V	Kemet C052K472K1X5CA	224297
C26	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C27	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
CR1 through CR4	Diode, Sil.	1N914	T.I.	530058
IC1	Integrated Circuit	CD4051BE	RCA	534139
IC2	Integrated Circuit	CD4051BE	RCA	534139
IC3	Integrated Circuit	CD4051BE	RCA	534139
IC4	Integrated Circuit	SN74L121N	T.I.	534146
IC5	Integrated Circuit	SN74L121N	T.I.	534146
K1	Relay (Form A)	RA3038-1051(S.P.D.T.)	Elec-Trol	471033
L1	Inductor	10 μH 10%	Jeffers 4445-2K	400245
P1	Connector, Coaxial		Applied Eng. Prod. 209	477317
P2	Connector, Coaxial		Applied Eng. Prod. 209	477317
Q1	Transistor, NPN	2N5109	RCA (ONLY)	528073
Q2	Transistor, NPN	2N5088	Motorola	528047
Q3 through Q6	Transistor, NPN	2N3904	Motorola	528071
R1	Resistor, Comp.	2 kΩ 5%	AB-CB	343329
R2	Resistor, Comp.	3 kΩ 5%	AB-CB	343346
R3	Resistor, Comp.	180 Ω 5%	AB-CB	343225
R4	Resistor, Comp.	16 Ω 5%	AB-CB	343120
R5	Resistor, Comp.	150 Ω 5%	AB-CB	343217
R6	Resistor, Comp.	5.6 Ω 5%	AB-CB	343072
R7	Resistor, Comp.	51 Ω 5%	AB-CB	343168
R8	Resistor, Comp.	51 kΩ 5%	AB-CB	343468
R9	Resistor, Comp.	51 Ω 5%	AB-CB	343168
R10	Resistor, Comp.	1 kΩ 5%	AB-CB	343300
R11	Resistor, Comp.	51 Ω 5%	AB-CB	343168
R12	Resistor, Comp.	56 kΩ 5%	AB-CB	343472
R13	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R14	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R15	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R16	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R17	Resistor, Comp.	16 kΩ 5%	AB-CB	343420
R18	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R19	Resistor, Comp.	16 kΩ 5%	AB-CB	343420
R20	Resistor, Comp.	16 kΩ 5%	AB-CB	343420
R21	Resistor, Var.	5 kΩ 10% 0.5W	Beckman 72PR5K	311308
R22	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R23	Resistor, Var.	5 kΩ 10% 0.5W	Beckman 72PR5K	311308
R24	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R25	Resistor, Comp.	16 kΩ 5%	AB-CB	343420
R26	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R27	Resistor, Var.	5 kΩ 10% 0.5W	Beckman 72PR5K	311308
R28	Resistor, Var.	100 kΩ 10% 0.5W	Beckman 72PR100K	311391
R29	Resistor, Comp.	20 kΩ 5%	AB-CB	343429
R30	Resistor, Var.	50 kΩ 10% 0.5W	Beckman 72PR50K	311393
R31	Resistor, Var.	10 kΩ 10% 0.5W	Beckman 72PR10K	311328
R32	Resistor, Comp.	2.7 kΩ 5%	AB-CB	343341
R33	Resistor, Comp.	2 kΩ 5%	AB-CB	343329
R34	Resistor, Comp.	3 kΩ 5%	AB-CB	343346
Z1	Mixer		Mini-Circuits SRA-1	423000
OUTPUT PC BOARD (A7)				
A1	Op. Amp.	LM318N	National Semiconductor	535031
A2	Op. Amp.	LM310N	National Semiconductor	535035
A3	Op. Amp.	LM318N	National Semiconductor	535031
C1	Not Used			
C2	Capacitor, Mica	2000 pF 5% 500V	Elmenco DM19-F202J	200500
C3	Capacitor, Mica	5 pF 10% 300V	Elmenco DM5-CC050K	205000
C4	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C5	Capacitor, Mica	820 pF 10% 200V	Kemet C052K821K2X5CA	224292
C6	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C7	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C8	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C9 through C19	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C20	Capacitor, Mica	2000 pF 5% 500V	Elmenco DM19-F202J	200500
C21	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C22	Capacitor, Cer.	1500 pF 5% 50V	Kemet C1210C152J5XAH	224274
C23	Capacitor, Cer.	0.33 μF 20% 50V	Kemet C1825C334M5XAH	224275
C24	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C25	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C26*	Capacitor, Mica	20 pF 5% 300V	Elmenco DM5-CC200J	205017
C27	Capacitor, Mica	5 pF 10% 300V	Elmenco DM5-CC050K	205000
C28	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C29	Capacitor, Mica	130 pF 5% 100V	Elmenco DM5-FA131J	205011
C30	Capacitor, Mica	130 pF 5% 100V	Elmenco DM5-FA131J	205011
C31	Capacitor, Mica	220 pF 5% 50V	Elmenco DM5-FY221J	205012
CR1 through CR8	Diode	PMS702-08	Parametric Industries	530162
CR9	Diode, Sil.	5082-2811	H.P.	530161

*Model 103D Only

TABLE OF REPLACEABLE PARTS (cont)

Reference		Description		BEC Part No.
OUTPUT PC BOARD (A7)				
K1	Relay (Form A)	RA3038-1051(S.P.D.T.)	Elec-Trol	471033
K2	Relay (Form A)	RA3038-1051(S.P.D.T.)	Elec-Trol	471033
L1 through L6	Choke, RF	5.6 μH 10%	Jeffers 4435-1K	400308
L7	Choke, RF	20 μH 5%	Jeffers 4445-6J	400258
P1	Connector, Coaxial		Applied Eng. Prod. 209	477317
P2	Connector, Coaxial		Applied Eng. Prod. 209	477317
P3	Connector, Coaxial		Applied Eng. Prod. 209	477317
R1	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R2	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R3	Resistor, Comp.	270 Ω 5%	AB-CB	343241
R4	Resistor, Comp.	270 Ω 5%	AB-CB	343241
R5	Resistor, Comp.	2 kΩ 5%	AB-CB	343329
R6	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R7	Resistor, Comp.	270 kΩ 5%	AB-CB	343541
R8	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R9	Resistor, Comp.	680 Ω 5%	AB-CB	343280
R10	Resistor, Comp.	680 Ω 5%	AB-CB	343280
R11	Resistor, Comp.	200 kΩ 5%	AB-CB	343529
R12	Resistor, MF	100 Ω 1%	RN55D	341200
R13	Resistor, Comp	2 kΩ 5%	AB-CB	343329
R14	Resistor, MF	1.33 kΩ 1%	RN55D	341312
R15	Resistor, MF	5.11 kΩ 1%	RN55D	341368
R16	Resistor, MF	100 Ω 1%	RN55D	341200
R17	Resistor, Comp.	5.6 kΩ 5%	AB-CB	343372
R18	Resistor, MF	15.0 kΩ 1%	RN55D	341417
R19	Resistor, MF	365 Ω 1%	RN55D	341254
R20	Resistor, CF	30 Ω 1% 1/4W	Pryofilm 62R375	305609
R21	Resistor, Comp.	5.6 kΩ 5%	AB-CB	343372
R22	Resistor, Comp.	1.2 kΩ 5%	AB-CB	343308
T1	Transformer, RF		Minicircuits T3-1T	410083
T2	Transformer, RF		Minicircuits T3-1T	410083
DRIVER PC BOARD (A8)				
C1	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C2	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C3	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C4	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C5	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C6	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C7	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C8	Capacitor, Mica	220 pF 5% 50V	Elmenco DM5 FY221J	205012
C9	Capacitor, Mica	43 pF 5% 300V	Elmenco DM5 EC430J	205014
C10	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C11	Capacitor, Mica	43 pF 5% 300V	Elmenco DM5 EC430J	205014
C12	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C13	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C14	Capacitor, Mica	8 pF 10% 300V	Elmenco DM5 CC080K	205001
C15	Capacitor, Mica	20 pF 5% 300V	Elmenco DM5 CC200J	205017
C16	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C17	Capacitor, Var.	3 - 10 pF 250V	Johnson #9372	281014
C18	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C19	Capacitor, Mica	5 pF 10% 300V	Elmenco DM5 CC050K	205000
C20	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C21	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C22	Capacitor, Mica	20 pF 5% 300V	Elmenco DM5 CC200J	205017
C23	Capacitor, Mica	20 pF 5% 300V	Elmenco DM5 CC200J	205017
C24	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5 FA151J	205009
C25	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C26	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5 FA151J	205009
C27	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C28	Capacitor, Mica	20 pF 5% 300V	Elmenco DM5 CC200J	205017
C29	Capacitor, Mica	20 pF 5% 300V	Elmenco DM5 CC200J	205017
C30	Capacitor, Cer	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C31	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C32	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5 FA151J	205009
C33	Capacitor, Mica	43 pF 5% 300V	Elmenco DM5 EC430J	205014
C34	Capacitor, Mica	20 pF 5% 300V	Elmenco DM5 CC200J	205017
C35	Capacitor, Cer	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C36	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C37	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C38	Capacitor, Mica	10 pF 5% 300V	Elmenco DM5-CC100J	205002
C39	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C40	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C41	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C42	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C43	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C44	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C45	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C46	Capacitor, Mica	82 pF 5% 300V	Elmenco DM5-EC820J	205016
C47	Capacitor, Mica	33 pF 5% 300V	Elmenco DM5-EC330J	205010
C48	Capacitor, Cer.	0.33 μF 20% 50V	Kemet C1825C334M5XAH	224275
C49	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C50	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C51	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C52	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C53	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C54	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C55	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C56	Capacitor, Mica	150 pG 5% 100V	Elmenco DM5-FA151J	205009
C57	Capacitor, Cer.	0.33 μF 20% 50V	Kemet C1825C334M5XAH	224275
C58	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C59	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C60	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C61	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C62	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C63	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C64	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C65	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
CR1	Diode, Sil.	5082-3188	H.P.	530165
CR2	Diode, Cap.	DHT3311-015	Crown Microwave	530761
CR3	Diode, Sil.	5082-3188	H.P.	530165
CR4	Diode, Cap.	DHT3311-015	Crown Microwave	530761
CR5	Diode, Sil.	5082-3188	H.P.	530165
CR6	Diode, Cap.	DHT3311-015	Crown Microwave	530761
CR7	Diode, Sil.	5082-3188	H.P.	530165
CR8	Diode, Sil.	5082-3188	H.P.	530165
CR9	Diode, Cap.	DHT3311-015	Crown Microwave	530761
CR10	Diode, Sil.	5082-3188	H.P.	530165
CR11	Diode, Sil.	MV1404	Motorola	530759
CR12	Diode, Sil.	MV1404	Motorola	530759
IC1 through IC5	Integrated Circuit	SP16488	Plessey	534138
K1	Relay (Form A)	RA3038-1051(S.P.S.T.)	Elec-Trol	471033
K1	Relay (Form A)	RA3038-1051(S.P.S.T.)	Elec-Trol	471033
K3	Relay (Form C)	DRR-5202105(S.P.D.T.)	Electro Design Systems	471034
K4	Relay (Form C)	DRR-5202105(S.P.D.T.)	Electro Design Systems	471034
L1	Choke, RF	2.7 μH 10%	Gowanda 10/271	400358
L2	Choke, RF	10 μH 10%	Gowanda 10/102	400361
L3	Choke, RF	10 μH 10%	Gowanda 10/102	400361
L4	Choke, RF	22 μH 10%	Gowanda 10/222	400360
L5	Choke, RF	3600 μH 5%	Gowanda 22/364	400381
L6	Choke, RF	0.22 μH 10%	Gowanda 10/220	400363
L7	Choke, RF	0.15 μH 10%	Gowanda 10/150	400362
L8	Choke, RF	22 μH 10%	Gowanda 10/222	400360
L9	Choke, RF	1200 μH 5%	Gowanda 22/124	400380
L10	Choke, RF	0.10 μH 10%	Jeffers 4416-1K	400299
L11	Choke, RF	22 μH 10%	Gowanda 10/222	400360
L12	Choke, RF	2.7 μH 10%	Gowanda 10/271	400358
L13	Choke, RF	0.12 μH 10%	Gowanda 10/120	400364
L14	Coil, RF	0.04 μH	Boonton Electronics	400379
L15	Choke, RF	180 μH 5%	Jeffers 1315-18J	400347
L16	Coil, RF	0.04 μH	Boonton Electronics	400379
L17	Choke, RF	22 μH 10%	Gowanda 10/222	400360
L18	Choke, RF	1.8 μH 10%	Gowanda 10/181	400365
L19	Choke, RF	2.7 μH 10%	Gowanda 10/271	400358
L20	Coil, RF	0.11 μH	Boonton Electronics	400378
L21 through L24	Choke, RF	10 μH 10%	Gowanda 10/102	400361
L25	Choke, RF	0.10 μH 10%	Jeffers 4416-1K	400299

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description			BEC Part No.
DRIVER PC BOARD (A8)				
P1 through P4	Connector, Coaxial		Applied Eng. Prod. 209	477317
Q1	Transistor, NPN	2N3904	Motorola	528071
Q2	Transistor, NPN	2N5179	Motorola	528080
Q3	Transistor, NPN	2N5179	Motorola	528080
Q4	Transistor, NPN	2N5109	RCA (ONLY)	528073
Q5	Transistor, NPN	2N5179	Motorola	528080
Q6	Transistor, NPN	2N3904	Motorola	528071
R1	Resistor, Comp.	4.7 kΩ 5%	AB-CB	343365
R2	Resistor, Comp.	6.8 kΩ 5%	AB-CB	343380
R3	Resistor, Comp.	680 Ω 5%	AB-CB	343280
R4	Resistor, Comp.	1.2 kΩ 5%	AB-CB	343308
R5	Resistor, Comp.	100 Ω 5%	AB-CB	343200
R6	Resistor, Comp.	100 Ω 5%	AB-CB	343200
R7	Resistor, Comp.	75 Ω 5%	AB-CB	343184
R8	Resistor, Comp.	100 Ω 5%	AB-CB	343200
R9	Resistor, Comp.	4.7 kΩ 5%	AB-CB	343365
R10	Resistor, Comp.	15 Ω 5%	AB-CB	343117
R11	Resistor, Comp.	1.2 kΩ 5%	AB-CB	343308
R12	Resistor, Comp.	62 Ω 5%	AB-CB	343176
R13	Resistor, Comp.	5.6 kΩ 5%	AB-CB	343372
R14	Resistor, Comp.	3.3 kΩ 5%	AB-CB	343350
R15	Resistor, Comp.	68 Ω 5%	AB-CB	343180
R16	Not Used			
R17	Resistor, Comp.	270 Ω 5%	AB-CB	343241
R18	Resistor, Comp.	240 Ω 5%	AB-CB	343237
R19	Resistor, Comp.	51 Ω 5%	AB-CB	343168
R20	Not Used			
R21	Resistor, Comp.	6.8 kΩ 5%	AB-CB	343380
R22	Resistor, Comp.	1.5 kΩ 5%	AB-CB	343317
R23	Resistor, Comp.	3 kΩ 5%	AB-CB	343346
R24	Resistor, Comp.	2 kΩ 5%	AB-CB	343329
R25	Resistor, Comp.	1.2 kΩ 5%	AB-CB	343308
R26	Resistor, Comp.	220 Ω 5%	AB-CB	343233
R27	Resistor, Comp.	180 Ω 5%	AB-CB	344225
R28	Resistor, Comp.	51 kΩ 5%	AB-CB	343468
R29	Resistor, Comp.	100 Ω 5%	AB-CB	343200
R30	Resistor, Comp.	6.2 Ω 5%	AB-CB	343076
R31	Resistor, Comp.	150 Ω 5%	AB-CB	344217
R32	Resistor, Comp.	18 Ω 5%	AB-CB	343125
R33	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R34	Resistor, Comp.	270 Ω 5%	AB-CB	343241
R35	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R36	Resistor, Comp.	1 kΩ 5%	AB-CB	343300
R37	Resistor, Comp.	4.3 kΩ 5%	AB-CB	343361
R38	Resistor, Comp.	2 kΩ 5%	AB-CB	343329
R39	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R40	Resistor, Comp.	270 Ω 5%	AB-CB	343241
R41	Resistor, Comp.	4.7 kΩ 5%	AB-CB	343365
Y1	Crystal	106.000 MHz	Valpey/Fisher	547028
Z1	Mixer		Mini-Circuits Lab SRA-1	423000
FILTER PC BOARD (A9)				
C1	Capacitor, Cer.	0.33 μF 20% 50V	Kemet C1825C334M5XAH	224275
C2	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C3	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C4	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C5	Capacitor, Cer.	6800 pF 10% 100V	Kemet C052K682K1X5CA	224299
C6	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C7	Capacitor, Cer.	0.012 μF 10% 50V	Kemet C052K123K5X5CA	224300
C8	Capacitor, Cer.	0.012 μF 10% 50V	Kemet C052K123K5X5CA	224300
C9	Capacitor, Cer.	0.033 μF 10% 50V	Kemet C052K333K5X5CA	224303
C10	Capacitor, Cer.	0.047 μF 10% 50V	Kemet C052K473K5X5CA	224304
C11	Capacitor, Cer.	0.033 μF 10% 50V	Kemet C052K333K5X5CA	224303
C12	Capacitor, Cer.	3300 pF 10% 100V	Kemet C052K332K1X5CA	224296
C13	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C14	Capacitor, Cer.	5600 pF 10% 100V	Kemet C052K562K1X5CA	224298
C15	Capacitor, Cer.	5600 pF 10% 100V	Kemet C052K562K1X5CA	224298
C16	Capacitor, Cer.	0.018 μF 10% 50V	Kemet C052K183K5X5CA	224301
C17	Capacitor, Cer.	0.022 μF 10% 50V	Kemet C052K223K5X5CA	224302
C18	Capacitor, Cer.	0.018 μF 10% 50V	Kemet C052K183K5X5CA	224301
C19	Capacitor, Cer.	2200 pF 10% 100V	Kemet C052K222K1X5CA	224295
C20	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C21	Capacitor, Cer.	3300 pF 10% 100V	Kemet C052K332K1X5CA	224296
C22	Capacitor, Cer.	3300 pF 10% 100V	Kemet C052K332K1X5CA	224296
C23	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C24	Capacitor, Cer.	0.012 μF 10% 50V	Kemet C052K123K5X5CA	224300
C25	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C26	Capacitor, Cer.	1200 pF 10% 100V	Kemet C052K122K1X5CA	224293
C27	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C28	Capacitor, Cer.	1500 pF 10% 100V	Kemet C052K152K1X5CA	224294
C29	Capacitor, Cer.	1500 pF 10% 100V	Kemet C052K152K1X5CA	224294
C30	Capacitor, Cer.	4700 pF 10% 100V	Kemet C052K472K1X5CA	224297
C31	Capacitor, Cer.	6800 pF 10% 100V	Kemet C052K682K1X5CA	224299
C32	Capacitor, Cer.	4700 pF 10% 100V	Kemet C052K472K1X5CA	224297
C33	Capacitor, Cer.	560 pF 10% 200V	Kemet C052K561K2X5CA	224290
C34	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C35	Capacitor, Cer.	820 pF 10% 200V	Kemet C052K821K2X5CA	224292
C36	Capacitor, Cer.	820 pF 10% 200V	Kemet C052K821K2X5CA	224292
C37	Capacitor, Cer.	2200 pF 10% 100V	Kemet C052K222K1X5CA	224295
C38	Capacitor, Cer.	3300 pF 10% 100V	Kemet C052K332K1X5CA	224296
C39	Capacitor, Cer.	2200 pF 10% 100V	Kemet C052K222K1X5CA	224295
C40	Capacitor, Mica	220 pF 5% 50V	Elmenco DM5-FY221J	205012
C41	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C42	Capacitor, Mica	360 pF 5% 50V	Elmenco DM5-FY361J	205027
C43	Capacitor, Mica	360 pF 5% 50V	Elmenco DM5-FY361J	205027
C44	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C45	Capacitor, Cer.	1500 pF 10% 200V	Kemet C052K152K1X5CA	224294
C46	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C47	Capacitor, Mica	120 pF 5% 100V	Elmenco DM5-FC121J	205022
C48	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C49	Capacitor, Mica	180 pF 5% 100V	Elmenco DM5-FA181J	205023
C50	Capacitor, Mica	180 pF 5% 100V	Elmenco DM5-FA181J	205023
C51	Capacitor, Cer.	560 pF 10% 200V	Kemet C052K561K2X5CA	224290
C52	Capacitor, Cer.	680 pF 10% 200V	Kemet C052K681K2X5CA	224291
C53	Capacitor, Cer.	560 pF 10% 200V	Kemet C052K561K2X5CA	224290
C54	Capacitor, Mica	51 pF 5% 300V	Elmenco DM5-EC510J	205020
C55	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C56	Capacitor, Mica	91 pF 5% 300V	Elmenco DM5-FC910J	205021
C57	Capacitor, Mica	91 pF 5% 300V	Elmenco DM5-FC910J	205021
C58	Capacitor, Mica	220 pF 5% 50V	Elmenco DM5-FY221J	205012
C59	Capacitor, Mica	330 pF 5% 50V	Elmenco DM5-FY331J	205029
C60	Capacitor, Mica	220 pF 5% 50V	Elmenco DM5-FY221J	205012
C61	Capacitor, Mica	33 pF 5% 300V	Elmenco DM5-EC330J	205010
C62	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C63	Capacitor, Mica	43 pF 5% 300V	Elmenco DM5-EC430J	205014
C64	Capacitor, Mica	43 pF 5% 300V	Elmenco DM5-EC430J	205014
C65	Capacitor, Mica	120 pF 5% 100V	Elmenco DM5-FC121J	205022
C66	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C67	Capacitor, Mica	120 pF 5% 100V	Elmenco DM5-FC121J	205022
C68	Capacitor, Mica	120 pF 5% 100V	Elmenco DM5-FC121J	205022
C69	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C70	Capacitor, Mica	91 pF 5% 300V	Elmenco DM5-FC910J	205021
C71	Capacitor, Mica	91 pF 5% 300V	Elmenco DM5-FC910J	205021
C72	Capacitor, Mica	62 pF 5% 300V	Elmenco DM5-EC620J	205015
C73	Capacitor, Mica	82 pF 5% 300V	Elmenco DM5-EC820J	205016
C74	Capacitor, Mica	62 pF 5% 300V	Elmenco DM5-EC620J	205015
C75	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C76	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C77	Capacitor, Var.	1.5 - 4 pF	Johanson 9371	281020
C78	Capacitor, Var.	1.5 - 4 pF	Johanson 9371	281020
C79	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C80	Capacitor, Mica	51 pF 5% 300V	Elmenco DM5-EC510J	205020
C81	Capacitor, Mica	68 pF 5% 300V	Elmenco DM5-EC680J	205007
C82	Capacitor, Var.	3.5 - 18 pF	Johanson 9373	281011
C83	Capacitor, Mica	51 pF 5% 300V	Elmenco DM5-EC510J	205020
C84	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C85	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C86	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C87	Capacitor, Var.	1.5 - 4 pF	Johanson 9371	281020
C88	Capacitor, Var.	1.5 - 4 pF	Johanson 9371	281020
C89	Capacitor, Mica	150 pF 5% 100V	Elmenco DM5-FA151J	205009
C90	Capacitor, Mica	68 pF 5% 300V	Elmenco DM5-EC680J	205007
C91	Capacitor, Mica	82 pF 5% 300V	Elmenco DM5-EC820J	205016
C92	Capacitor, Var.	3.5 - 18 pF	Johanson 9373	281011
C93	Capacitor, Mica	68 pF 5% 300V	Elmenco DM5-EC680J	205007

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description			BEC Part No.
FILTER PC BOARD (A9)				
C94	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C95	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C96	Capacitor, Cer.	0.33 μF 20% 50V	Kemet C1825C334M5XAH	224275
C97	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C98	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C99	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
CR1 through CR45	Diode, Pin	5082 3188	H.P.	530165
K1	Relay (Form C)	DRR 5202105(S.P.D.T.)	Electro Design Systems	471034
L1	Choke, RF	56 μH 10%	Gowanda 10/562	400359
L2	Coil, RF	27 μH 10%	Gowanda 10/272	400374
L3	Coil, RF	27 μH 10%	Gowanda 10/272	400374
L4	Coil, RF	27 μH 10%	Gowanda 10/272	400374
L5	Choke, RF	15 μH 10%	Gowanda 10/152	400373
L6	Choke, RF	15 μH 10%	Gowanda 10/152	400373
L7	Choke, RF	12 μH 10%	Gowanda 10/122	400372
L8	Choke, RF	6.8 μH 10%	Gowanda 10/681	400371
L9	Choke, RF	6.8 μH 10%	Gowanda 10/681	400371
L10	Choke, RF	6.8 μH 10%	Gowanda 10/681	400371
L11	Choke, RF	3.3 μH 10%	Gowanda 10/331	400370
L12	Choke, RF	3.3 μH 10%	Gowanda 10/331	400370
L13	Choke, RF	3.3 μH 10%	Gowanda 10/331	400370
L14	Choke, RF	1.5 μH 10%	Gowanda 10/151	400383
L15	Choke, RF	1.5 μH 10%	Gowanda 10/151	400383
L16	Choke, RF	1.8 μH 10%	Gowanda 10/181	400365
L17	Coil, RF	0.82 μH 10%	Gowanda 10/820	400375
L18	Coil, RF	0.82 μH 10%	Gowanda 10/820	400375
L19	Coil, RF	0.82 μH 10%	Gowanda 10/820	400375
L20	Choke, RF	0.39 μH 10%	Gowanda 10/390	400367
L21	Choke, RF	0.39 μH 10%	Gowanda 10/390	400367
L22	Choke, RF	0.47 μH 10%	Gowanda 10/470	400368
L23	Choke, RF	0.22 μH 10%	Gowanda 10/220	400363
L24	Choke, RF	0.22 μH 10%	Gowanda 10/220	400363
L25	Choke, RF	0.22 μH 10%	Gowanda 10/220	400363
L26	Choke, RF	0.12 μH 10%	Gowanda 10/120	400364
L27	Choke, RF	0.12 μH 10%	Gowanda 10/120	400364
L28	Coil, RF	0.085 μH 10%	Boonton Electronics	400385
L29	Coil, RF	0.05 μH 10%	Boonton Electronics	400376
L30	Coil, RF	0.05 μH 10%	Boonton Electronics	400376
L31	Choke, RF	0.33 μH 10%	Gowanda 10/330	400366
L32	Choke, RF	0.33 μH 10%	Gowanda 10/330	400366
L33	Choke, RF	0.39 μH 10%	Gowanda 10/390	400367
L34	Choke, RF	0.39 μH 10%	Gowanda 10/390	400367
L35 through L38	Choke, RF	56 μH 10%	Gowanda 10/562	400359
L39	Coil, RF	0.1 μH 10%	Jeffers 4416-1K	400299
L40	Coil, RF	0.085 μH 10%	Boonton Electronics	400385
P1	Connector, Coaxial		Applied Eng. Prod. 209	477317
P2	Connector, Coaxial		Applied Eng. Prod. 209	477317
R1	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R2	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R3	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R4	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R5	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R6	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R7	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R8	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R9	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R10	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R11	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R12	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R13	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R14	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R15	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R16	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R17	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R18	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R19	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R20	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R21	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R22	Not Used			
R23	Not Used			
R24	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R25	Resistor, Comp.	30 kΩ 5%	AB-CB	343446
R26	Not Used			
R27	Not Used			
R28	Resistor, Comp.	750 Ω 5%	AB-CB	343284
R29	Resistor, Comp.	1.5 kΩ 5%	AB-CB	343317
R30	Resistor, Comp.	1.5 kΩ 5%	AB-CB	343317
R31	Resistor, Comp.	51 Ω 5%	AB-CB	343168
PRESCALER PC BOARD (A10)				
C1 through C4	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C5	Capacitor, Tant.	22 μF 10% 25V	Sprague 196D226X9025LA3	283308
C6	Capacitor, Tant.	10 μF 20% 25V	Sprague 196D106X0025KA1	283293
C7	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C8	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C9	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C10	Capacitor, Mica	68 pF 5% 300V	Elmenco DM5-EC680J	205007
C11	Capacitor, Tant.	22 μF 10% 25V	Sprague 196D226X9025LA3	283308
C12	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C13	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C14	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C15	Capacitor, Tant.	22 μF 10% 25V	Sprague 196D226X9025LA3	293308
C16	Capacitor, Mica	220 pF 5% 50V	Elmenco DM5-FY221J	205012
C17	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C18	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C19	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
CR1	Diode, Sil.	FD 700	Fairchild	530166
CR2	Diode, Sil.	FD 700	Fairchild	530166
IC1	Integrated Circuit	MC10116P (Triple Line Receiver)	Motorola	534135
IC2	Integrated Circuit	MC10102P(NOR Gate)	Motorola	534134
IC3	Resistor Network	470 Ω 2% 1.1W	CTS 750-81-R470	345018
IC4	Integrated Circuit	MC10231P (Dual D Flip Flop)	Motorola	534136
IC5	Resistor Network	470 Ω 2% 1.1W	CTS 750-81-R470	345018
IC6	Integrated Circuit	MC10131P (Dual D Flip Flop)	Motorola	534137
K1	Relay (Form C)	DRR 5202105(S.P.D.T.)	Electro Design Systems	471034
L1	Choke, RF	56 μH 10%	Gowanda 10/562	400359
L2	Choke, RF	2.7 μH 10%	Gowanda 10/271	400358
P1	Connector, Coaxial		Applied Eng. Prod. 209	477317
P2	Connector, Coaxial		Applied Eng. Prod. 209	477317
P3	Connector, Coaxial		Applied Eng. Prod. 209	477317
Q1	Transistor, NPN	2N5179	Motorola	528080
Q2	Transistor, FET	2N4416	Motorola	528072
R1	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R2	Resistor, Comp.	620 Ω 5%	AB-CB	343276
R3	Resistor, Comp.	33 Ω 5%	AB-CB	343150
R4	Resistor, Comp.	1 MΩ 5%	AB-CB	343600
R5	Resistor, Comp.	33 kΩ 5%	AB-CB	343450
R6	Resistor, Comp.	1 kΩ 5%	AB-CB	343300
R7	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R8	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R9	Resistor, Comp.	2.2 kΩ 5%	AB-CB	343333
R10	Resistor, Var.	1 kΩ 10% 0.5W	Beckman 72PR1K	311316
R11	Resistor, Comp.	2.7 kΩ 5%	AB-CB	343341
R12	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R13	Resistor, Comp.	220 Ω 5%	AB-CB	343233
R14	Resistor, Comp.	510 Ω 5%	AB-CB	343268
PHASE LOCK DIVIDER PC BOARD (A11) MODEL 103D ONLY				
C1	Capacitor, Mica	220 pF 5% 50V	Elmenco DM5-FY221J	205012
C2	Capacitor, Mica	220 pF 5% 50V	Elmenco DM5-FY221J	205012

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description			BEC Part No.
PHASE LOCK DIVIDER PC BOARD (A11) MODEL 103D ONLY				
C3	Capacitor, Mica	20 pF 5% 300V	Elmenco DM5-CC200J	205017
C4	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C5	Capacitor, Mica	220 pF 5% 50V	Elmenco DM5-FY221J	205012
C6	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C7	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C8	Capacitor, Cer.	1000 pF 10% 200V	Kemet C052K102K2X5CA	224289
C9	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
C10	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C11	Capacitor, Cer.	0.01 μF 10% 100V	Kemet C052K103K1X5CA	224288
IC1	Integrated Circuit	SP8601B(Counter)	Plessey	534085
IC2	Integrated Circuit	SN74S74N(Flip Flop)	T.I.	534129
L1	Choke, RF	10 μH 10%	Gowanda 10/102	400361
L2	Choke, RF	10 μH 10%	Gowanda 10/102	400361
P1	Connector, Coaxial		Applied Eng. Prod. 209	477317
P2	Connector, Coaxial		Applied Eng. Prod. 209	477317
Q1	Transistor, NPN	2N5179	Motorola	528080
Q2	Transistor, NPN	2N5179	Motorola	528080
R1	Resistor, Comp.	6.8 kΩ 5%	AB-CB	343380
R2	Resistor, Comp.	1.5 kΩ 5%	AB-CB	343317
R3	Resistor, Comp.	1 kΩ 5%	AB-CB	343300
R4	Resistor, Comp.	220 Ω 5%	AB-CB	343233
R5	Resistor, Comp.	100 Ω 5%	AB-CB	343200
R6	Resistor, Comp.	22 Ω 5%	AB CB	343133
R7	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R8	Resistor, Comp.	330 Ω 5%	AB-CB	343250
R9	Resistor, Comp.	750 Ω 5%	AB-CB	343284
R10	Resistor, Comp.	560 Ω 5%	AB CB	343272
R11	Resistor, Comp.	1 kΩ 5%	AB-CB	343300
R12	Resistor, Comp.	1.8 kΩ 5%	AB-CB	343325
R13	Resistor, Comp.	470 Ω 5%	AB EB	344265
R14	Resistor, Comp.	33 kΩ 5%	AB-CB	343450
FREQUENCY DIVIDER PC BOARD (A13)				
C1	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C2	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C3	Capacitor, Cer.	220 pF 10% 200V	Kemet C052K221K2X5CA	224306
C4 through C17	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
C18	Capacitor, Mica	82 pF 5% 300V	Elmenco DM5-EC820J	205016
C19 through C31	Capacitor, Cer.	0.1 μF 10% 50V	Kemet C052K104K5X5CA	224287
CR1	Diode, Sil.	1N914	T.I.	530058
CR2	Diode, Sil.	1N914	T.I.	530058
IC1	Integrated Circuit	MC10102P	Motorola	534134
IC2	Integrated Circuit	MC10102P	Motorola	534134
IC3	Integrated Circuit	MC10231P	Motorola	534137
IC4	Integrated Circuit	MC10102P	Motorola	534134
IC5	Integrated Circuit	MC10136L	Motorola	534179
IC6	Integrated Circuit	MC10136L	Motorola	534179
K1	Relay (Form C)	DRR 5202105(S.P.D.T.)	Electro Design Systems	471034
K2	Relay (Form C)	DRR 5202105(S.P.D.T.)	Electro Design Systems	471034
L1 through L9	Choke, RF	5.6 μH 10%	Jeffers 4435-1K	400308
P1*	Connector, Coaxial		Applied Eng. Prod. 209	477317
P2 through P6	Connector, Coaxial		Applied Eng. Prod. 209	477317
R1	Resistor, Comp	82 Ω 5%	AB-CB	343188
R2*	Resistor, Comp.	390 Ω 5%	AB-CB	343257
R3	Resistor, MF	165 Ω 1%	RN55D	341221
R4	Resistor, MF	68.1 Ω 1%	RN55D	341180
R5	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R6	Resistor, Comp.	82 Ω 5%	AB-CB	343188
R7	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R8	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R9	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R10	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R11	Resistor, Comp.	82 Ω 5%	AB-CB	343188
R12	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R13 through R16	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R17	Resistor, Comp.	82 Ω 5%	AB-CB	343188
R18	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R19	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R20	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R21	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R22	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R23	Resistor, Comp.	62 Ω 5%	AB-CB	343176
R24	Resistor, Comp.	180 Ω 5%	AB-CB	343225
R25	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R26	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R27	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R28	Resistor, Comp.	510 Ω 5%	AB CB	343268
R29	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R30	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R31	Resistor, Comp.	510 Ω 5%	AB-CB	343268
T1	Transformer, RF		Mini-Circuits T3-1T	410083
POWER SUPPLY PC BOARD (A14)				
A1	Op. Amp.	LM301AN	National Semiconductor	535012
A2	Op. Amp.	LM301AN	National Semiconductor	535012
C1 through C4	Capacitor, Cer.	0.068 μF 10% 250V	Mepco C280MAH/A68K	234146
C5	Capacitor, Elec.	2000 μF 40V	Mallory PFP	283320
C6	Capacitor, Elec.	2000 μF 40V	Mallory PFP	283320
C7	Capacitor, Elec.	5000 μF 20V	Mallory PFP	283321
C8	Capacitor, Elec.	5000 μF 20V	Mallory PFP	283321
C9	Capacitor, Tant.	10 μF 20% 25V	Sprague 196D106X0025KA1	283293
C10	Capacitor, Mica	33 pF 5% 300V	Elmenco DM5-EC330J	205010
C11	Capacitor, Tant.	10 μF 20% 25V	Sprague 196D106X0025KA1	283293
C12	Capacitor, Mica	33 pF 5% 300V	Elmenco DM5-EC330J	205010
C13	Capacitor, Tant.	10 μF 20% 25V	Sprague 196D106X0025KA1	283293
C14	Capacitor, Tant.	10 μF 20% 25V	Sprague 196D106X0025KA1	283293
C15	Capacitor, Tant.	100 μF 20% 20V	Sprague 196D107X0020TE4	283313
CR1	Diode, Bridge	KBP-02	General Instrument	532013
CR2	Diode, Bridge	KBP-02	General Instrument	532013
CR3	Diode, Bridge	VJ-148	Varo	532012
CR4	Diode, Bridge	VS-248	Varo	532014
CR5 through CR11	Diode, Sil.	1N4001	Motorola	530151
CR12	Diode, Zener	1N827(5.9 - 6.5V)	Motorola	530072
CR13	Diode, Sil.	1N4001	Motorola	530151
CR14	Diode, Sil.	1N4001	Motorola	530151
IC1	Integrated Circuit	μA7805UC(Regulator)	Fairchild	535011
IC2	Integrated Circuit	μA7805UC(Regulator)	Fairchild	535011
IC3	Integrated Circuit	LM323K(Regulator)	National Semiconductor	535024
IC4	Integrated Circuit	LM320K-5.2 (Regulator)	National Semiconductor	535033
R1	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R2	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R3	Resistor, Comp.	3.0 kΩ 5%	AB-CB	343346
R4	Resistor, Comp.	3.0 kΩ 5%	AB-CB	343346
R5	Resistor, MF	1.10 kΩ 1%	RN55	341304
R6	Resistor, MF	1.10 kΩ 1%	RN55	341304

*Model 103D Only

*Model 103D Only

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description			BEC Part No.
POWER SUPPLY PC BOARD (A14)				
R7	Resistor, MF	1.10 kΩ 1%	RN55	341304
R8	Resistor, Var.	200 Ω 10% 1/2W	Beckman 72PR200	311304
R9	Resistor, MF	750 Ω 1%	RN55	341284
R10	Resistor, MF	1.10 kΩ 1%	RN55	341304
R11	Resistor, MF	10.0 kΩ 1%	RN55	341400
R12	Resistor, MF	10.0 kΩ 1%	RN55	341400
R13	Resistor, MF	4.99 kΩ 1%	RN55	341367
DISPLAY TIME BASE PC BOARD (A16)				
C1	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C2	Capacitor, Cer	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C3	Capacitor, Tant.	22 μF 10% 25V	Sprague 109D226X9025LA3	283308
C4	Capacitor, Cer.	1.0 μF 20% 50V	AVX SR305E105MAA	224264
C5	Capacitor, Mica	680 pF 1% 300V	Elmenco DM15-F681F	200015
IC1	Integrated Circuit	SN7404N(Inverter)	T.I.	534042
IC2	Integrated Circuit	SN7490N(Counter)	T.I.	534035
IC3	Integrated Circuit	SN7400N (NAND Gate)	T.I.	534041
IC4	Integrated Circuit	SN7410N (NAND Gate)	T.I.	534041
IC5	Integrated Circuit	SN7490N(Counter)	T.I.	534035
IC6	Integrated Circuit	SN7400N (NAND Gate)	T.I.	534034
IC7	Integrated Circuit	SN7490N(Counter)	T.I.	534035
IC8	Integrated Circuit	SN7490N(Counter)	T.I.	534035
IC9	Integrated Circuit	SN7472N(Flip Flop)	T.I.	534032
IC10	Integrated Circuit	SN7490N(Counter)	T.I.	534035
IC11	Integrated Circuit	SN75450N(Driver)	T.I.	535009
IC12	Integrated Circuit	SN7490N(Counter)	T.I.	534035
L1	Choke, RF	5.6 μH 10%	Jeffers 4435-1K	400308
L2	Choke, RF	82 μH 5%	Jeffers 1315 10J	400318
Q1	Transistor, NPN	2N3904	Motorola	528071
R1	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R2	Resistor, Comp.	150 Ω 5%	AB-CB	343217
R3	Resistor, Comp.	390 Ω 5%	AB-CB	343257
R4 through R7	Resistor, Comp.	1.0 kΩ 5%	AB-CB	343300
R8	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R9	Resistor, Comp.	510 Ω 5%	AB-CB	343268
R10	Resistor, Comp.	510 Ω 5%	AB CB	343268
Y1	Crystal, Oscillator	1 MHz	Vectron Labs CO-251	547901
MASTER PC BOARD, MODEL 103D ONLY				
C1301 through C1310	Capacitor, Cer.	0.01 μF 100V	Erie 805 000X5V0103Z	224119
J1301	Connector, 22 Pin		Amphenol 143 022-03	479231
J1302	Connector, 22 Pin		Amphenol 143-022-03	479231
J1303	Connector, 22 Pin		Amphenol 143 022-03	479231
PHASE LOCK TIME BASE PC BOARD, MODEL 103D ONLY				
C1501 through C1504	Capacitor, Cer.	0.01 μF 100V	Erie 805-000X5V0103Z	224119
C1505	Capacitor, Cer.	1000 pF 500V GMV	RMC BG	224114
C1506	Capacitor, Tant.	6.8 μF 10% 35V	Sprague 196D685X9035KA1	283217
CR1501	Diode, Sil.	1N914	T.I.	530058
CR1502	Diode, Sil.	1N914	T.I.	530058
IC1501	Integrated Circuit	SN74L00N (NAND Gate)	T.I.	534002
IC1502 through IC1505	Integrated Circuit	SN74L90N(Counter)	T I	534079
IC1506	Integrated Circuit	SN7490N(Counter)	T.I.	534035
Q1501	Transistor, NPN	2N3904	Motorola	528071
Q1502	Transistor, PNP	2N3906	Motorola	528076
R1501	Resistor, Comp.	4.7 kΩ 5%	AB-CB	343365
R1502	Resistor, Comp.	680 Ω 5%	AB-CB	343280
R1503	Resistor, Comp.	680 Ω 5%	AB-CB	343280
R1504	Resistor, Comp.	27 kΩ 5%	AB-CB	343441
R1505	Resistor, Comp.	3.3 kΩ 5%	AB-CB	343350
R1506	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
R1507	Resistor, Comp.	5.1 kΩ 5%	AB-CB	343368
Y1501	Crystal, Oscillator	1 MHz	Vectron Labs 251-2258	547902
PHASE DETECTOR PC BOARD, MODEL 103D ONLY				
A1601 through A1605	Op. Amp.	LM301AN	National Semiconductor	535012
A1606	Op. Amp.	CA6741T	RCA	535020
C1601	Capacitor, Cer.	1 nF 500V GMV	RMC BG	224114
C1602	Capacitor, Cer.	0.01 μF 100V	Erie 805-000X5V0103Z	224119
C1603	Capacitor, Cer.	0.01 μF 100V	Erie 805-000X5V0103Z	224119
C1604	Capacitor, Tant.	6.8 μF 10% 35V	Sprague 196D685X9035KA1	283217
C1605	Capacitor, Cer.	1 nF 500V GMV	RMC BG	224114
C1606	Capacitor, PE	0.1 μF 10% 100V	Mepco C280MAH/A100K	234080
C1607	Capacitor, PE	0.1 μF 10% 100V	Mepco C280MAH/A100K	234080
C1608	Capacitor, Cer.	33 pF 5% 1 kV	Sprague C030B102G330J	224139
C1609	Capacitor, Cer.	33 pF 5% 1 kV	Sprague C030B102G330J	224139
C1610	Capacitor, Cer.	33 pF 5% 1 kV	Sprague C030B102G330J	224139
C1611	Capacitor, Tant.	47 μF 10% 20V	Sprague 196D476X9020LA3	283219
C1612	Capacitor, Cer.	33 pF 5% 1 kV	Sprague C030B102G330J	224139
C1613	Capacitor, Tant.	47 μF 10% 20V	Sprague 196D476X9020LA3	283219
C1614	Capacitor, PE	0.1 μF 10% 100V	Mepco C280MAH/A100K	234080
C1615	Capacitor, PE	0.033 μF 10% 200V	Sprague 192P33392	234045
C1616	Capacitor, PE	0.068 μF 5% 200V	Sprague 192P68352	234051
C1617	Capacitor, PE	0.033 μF 10% 200V	Sprague 192P33392	234045
C1618	Capacitor, PE	0.068 μF 5% 200V	Sprague 192P68352	234051
C1619	Capacitor, Cer.	33 pF 5% 1 kV	Sprague C030B102G330J	224139
CR1601	Diode, Zener	1N5227B (3.6V)	Motorola	530095
CR1602	Diode, Zener	1N5227B (3.6V)	Motorola	530095
CR1603	Diode, Sil.	1N914	T.I.	530058
CR1604	Diode, Sil.	1N914	T.I.	530058
CR1605	Diode, Sil.	1N914	T.I.	530058
IC1601	Integrated Circuit	SN7474N (Flip Flop)	T.I.	534080
IC1602	Integrated Circuit	SN74L02N (NOR Gate)	T.I.	534086
IC1603	Integrated Circuit	SN74L00N (NAND Gate)	T.I.	534002
IC1604	Integrated Circuit	SN74L10N (NAND Gate)	T.I.	534029
Q1601	Transistor, PNP	2N5087	Motorola	528042
Q1602	Transistor, NPN	2N5088	Motorola	528047
Q1603	Transistor, NPN	2N5088	Motorola	528047
Q1604	Transistor, FET	2N5949	T.I.	528019
Q1605	Transistor, NPN	2N5088	Motorola	528047
R1601	Resistor, Comp.	220 Ω 5%	AB-CB	343233
R1602	Resistor, Comp.	4.7 kΩ 5%	AB-CB	343365
R1603	Resistor, MF	309 kΩ 1%	RN55	341547
R1604	Resistor, MF	1 kΩ 1%	RN55	341300
R1605	Resistor, MF	1 kΩ 1%	RN55	341300
R1606	Resistor, MF	309 kΩ 1%	RN55	341547
R1607	Resistor, MF	100 kΩ 1%	RN55	341500
R1608	Resistor, MF	100 kΩ 1%	RN55	341500
R1609 through R1612	Resistor, MF	10 kΩ 1%	RN55	341400
R1613	Resistor, MF	866 kΩ 1%	RN60	342590
R1614	Resistor, MF	866 kΩ 1%	RN60	342590
R1615	Resistor, MF	100 kΩ 1%	RN55	341500
R1616	Resistor, Comp.	100 kΩ 5%	AB CB	343500

TABLE OF REPLACEABLE PARTS (cont)

Reference		Description		BEC Part No.
PHASE DETECTOR PC BOARD, MODEL 103D ONLY				
R1617	Resistor, Comp.	120 kΩ 5%	AB-CB	343508
R1618	Resistor, MF	100 kΩ 1%	RN55	341500
R1619	Resistor, MF	100 kΩ 1%	RN55	341500
R1620	Resistor, MF	49.9 kΩ 1%	RN55	341467
R1621	Resistor, MF	100 kΩ 1%	RN55	341500
R1622	Resistor, MF	33.2 kΩ 1%	RN55	341450
R1623	Resistor, Comp.	4.7 kΩ 5%	AB-CB	343365
R1624	Resistor, MF	604 Ω 1%	RN55	341275
R1625	Resistor, MF	100 kΩ 1%	RN55	341500
R1626	Resistor, MF	100 kΩ 1%	RN55	341500
R1627	Resistor, Comp.	220 Ω 5%	AB-CB	343233
R1628	Resistor, MF	100 kΩ 1%	RN55	341500
R1629	Resistor, MF	100 kΩ 1%	RN55	341500
COUNTER PC BOARD, MODEL 103D ONLY				
C1701	Capacitor, Tant.	22 µF 10% 25V	Sprague 196D226X9025LA3	283308
C1702	Capacitor, Tant.	6.8 µF 10% 35V	Sprague 196D685X9035KA1	283217
C1703	Capacitor, Cer.	1000 pF 500V GMV	RMC BG	224114
CR1701	Diode, Sil.	1N914	T.I.	530058
IC1701	Integrated Circuit	SN7474N(Flip Flop)	T.I.	534080
IC1702	Integrated Circuit	SN7408N(AND Gate)	T.I.	534083
IC1703	Integrated Circuit	SN7430N (NAND Gate)	T.I.	534045
IC1704	Integrated Circuit	SN74L122N (Monostable)	T.I.	534063
IC1705	Integrated Circuit	SN7402N (NOR Gate)	T.I.	534027
IC1706	Integrated Circuit	SN74L75N(Latch)	T.I.	534081
IC1707	Integrated Circuit	SN74163N(Counter)	T.I.	534077
IC1708	Integrated Circuit	SN7420N (NAND Gate)	T.I.	534058
IC1709	Integrated Circuit	SN74L75N(Latch)	T.I.	534081
IC1710	Integrated Circuit	SN74163N(Counter)	T.I.	534077
IC1711	Integrated Circuit	SN7474N(Flip Flop)	T.I.	534080
IC1712	Integrated Circuit	SN74L75N(Latch)	T.I.	534081
IC1713	Integrated Circuit	SN74163N(Counter)	T.I.	534077
IC1714	Integrated Circuit	SN74L75N(Latch)	T.I.	534081
IC1715	Integrated Circuit	SN74163N(Counter)	T.I.	534077
IC1716	Integrated Circuit	SN7402N (NOR Gate)	T.I.	534027
IC1717	Integrated Circuit	SN74L75N(Latch)	T.I.	534081
IC1718	Integrated Circuit	SN74163N(Counter)	T.I.	534077
R1701	Resistor, Comp.	1 kΩ 5%	AB-CB	343300
R1702	Resistor, Comp.	1 kΩ 5%	AB-CB	343300
R1703	Resistor, MF	15 kΩ 1%	RN55	341417
VFO BOARD				
C1901	Capacitor, FT	470 pF Modified	AB SS5D-4712	227116
C1902	Capacitor, FT	470 pF 20% 500V	AB FA5C-4712	227112
C1903	Capacitor, Tant.	100 µF 20% 20V	Sprague 196D107X0020TE4	283313
C1904*	Capacitor, Cer.	8.2 pF 5% 1000V	Sprague C035B102S8R2D	224225
C1904*	Capacitor, Cer.	8.2 pF 0.5 pF 1000V	Sprague C034B102D8R2D	224283
		One of the above to be selected during calibration		
C1905	Capacitor, Mica	100 pF 5% 300V	Elmenco DM5-FC101J	205006
C1906	Capacitor, Mica	100 pF 5% 300V	Elmenco DM5-FC101J	205006
C1907	Capacitor, Cer.	20 pF 5% 500V	Erie 301-000-C0G0-200J	220114
C1908	Not Used			
C1909	Capacitor, Cer	20 pF 5% 500V	Erie 301-000-C0G0-200J	220114
C1910	Capacitor, Cer.	4.7 pF 0.5% 500V	CRL TCZ-4R7	220111
C1911	Capacitor, FT	470 pF 20% 500V	AB FA5C-4712	227112
C1912	Capacitor, Tant.	10 µF 20% 25V	Sprague 196D106X0025KA1	283293
C1913	Capacitor, Var.	3.5 - 18 pF	Jackson	275152
C1914	Capacitor, FT	10 pF 10% 500V	AB FA5C-1001	227115
C1915	Capacitor, Mica	68 pF 5% 300V	Elmenco DM5-EC680J	205007
CR1901	Diode, Varactor	DKV65208	Alpha Industries	530757
CR1902	Diode, Varactor	DKV65208	Alpha Industries	530757
CR1903	Diode, Sil.	HP5082-2800	H.P.	530122
L1901	Coil, Var.		Mallory 516X235	400253
L1902	Choke, RF	6.8 µH 10%	Jeffers 4435-2K	400335
L1903	Choke, RF	1 µH 10%	Jeffers 4425-6K	400248
L1904	Choke, RF	4.7 µH 10%	Jeffers 4425-14K	400292
L1905	Choke, RF	4.7 µH 10%	Jeffers 4425-14K	400292
L1906	Choke, RF	10 µH 10%	Jeffers 4445-2K	400245
Q1901	Transistor, FET	2N4416	Motorola	528072
R1901	Resistor, MF	51.1 kΩ 1%	RN55	341468
R1902	Resistor, MF	243 Ω 1%	RN55	341237
R1903	Resistor, MF	1.0 kΩ 1%	RN55	341300
R1904	Resistor, Comp.	150 Ω 5%	AB-CB	343217
R1905	Resistor, Comp.	62 Ω 5%	AB-CB	343176
R1906	Resistor, Comp.	150 Ω 5%	AB-CB	343217
R1907	Resistor, MF	1.0 kΩ 1%	RN55	341300
R1908	Resistor, MF	604 Ω 1%	RN55	341275
MODULATION PC BOARD (A41)				
A1	Op. Amp.	LM318N	National Semiconductor	535031
A2	Op. Amp.	LM310N	National Semiconductor	535035
A3	Op. Amp.	LM301AN	National Semiconductor	535012
A4	Op. Amp.	LM311N	National Semiconductor	535034
A5	Op. Amp.	LM310N	National Semiconductor	535035
A6	Op. Amp.	LM318N	National Semiconductor	535031
A7	Op. Amp.	LF356P	T.I.	535040
C1	Not Used			
C2	Capacitor, Mica	5 pF 10% 300V	Elmenco DM5-CC050K	205000
C3	Capacitor, Cer.	0.1 µF 20% 50V	AVX SR215E104MAA	224268
C4	Capacitor, Cer.	1000 pF 10% 100V	AVX SR151C102KAA	224270
C5	Capacitor, Cer.	0.1 µF 20% 50V	AVX SR215E104MAA	224268
C6	Not Used			
C7	Capacitor, Cer.	1.0 µF 20% 50V	AVX SR305E105MAA	224264
C8	Capacitor, Cer.	3300 pF 10% 250V	Sprague B251G332K	224177
C9	Capacitor, Mica	33 pF 5% 300V	Elmenco DM5-EC330J	205010
C10	Capacitor, Tant.	10 µF +75/-15% 15V	Mallory CL23BE100UNE	283294
C11	Capacitor, Mica	27 pF 5% 300V	Elmenco DM5-EC270J	205008
C12	Capacitor, Tant.	22 µF 10% 25V	Sprague 196D226X9025LA3	283308
C13 through C16	Capacitor, Tant.	100 µF 20% 20V	Sprague 196D107X0020TE4	283313
C17	Capacitor, Cer.	0.01 µF 10% 100V	AVX SR201C103KAA	224269
C18 through C20	Capacitor, Tant.	10 µF +75/-15% 15V	Mallory CL23B100UNE	283294
C21	Capacitor, Mica	100 pF 5% 300V	Elmenco DM5-FC101J	205006
CR1	Diode, Zener	1N5235B (6.8V)	Motorola	530089
CR2	Diode, Sil.	1N914	T.I.	530058
DS1	Lamp	#1869	Chicago	545123
IC1	Integrated Circuit	78L05AWC (Voltage Reg.)	Fairchild	535044
IC2	Integrated Circuit	NE566V (Tone Decoder)	Signetics	535036
IC3	Integrated Circuit	SN74LS132N (NAND Gate)	T.I.	534102
K1	Relay (Form A)	RA30381051(S.P.D.T.)	Elec-Trol	471033
Q1	Transistor, NPN	2N3904	Motorola	528071
R1	Not Used			
R2	Resistor, MF	10.0 kΩ 1%	RN55D	341400
R3	Resistor, MF	19.6 kΩ 1%	RN55D	341428
R4	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R5	Resistor, Var.	5 kΩ 10% 0.5W	Beckman 72XWR5K	311307
R6	Resistor, MF	5.11 kΩ 1%	RN55D	341368
R7	Resistor, MF	22.1 kΩ 1%	RN55D	341433
R8	Resistor, Comp.	2 kΩ 5%	AB-CB	343329
R9	Resistor, Comp.	1.5 kΩ 5%	AB-CB	343317
R10	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R11	Resistor, MF	11.0 kΩ 1%	RN55D	341404
R12	Resistor, Var.	5. kΩ 10% 0.5W	Beckman 72XWR5K	311307
R13	Resistor, MF	10 [illegible]	RN55D	341100

TABLE OF REPLACEABLE PARTS (cont)

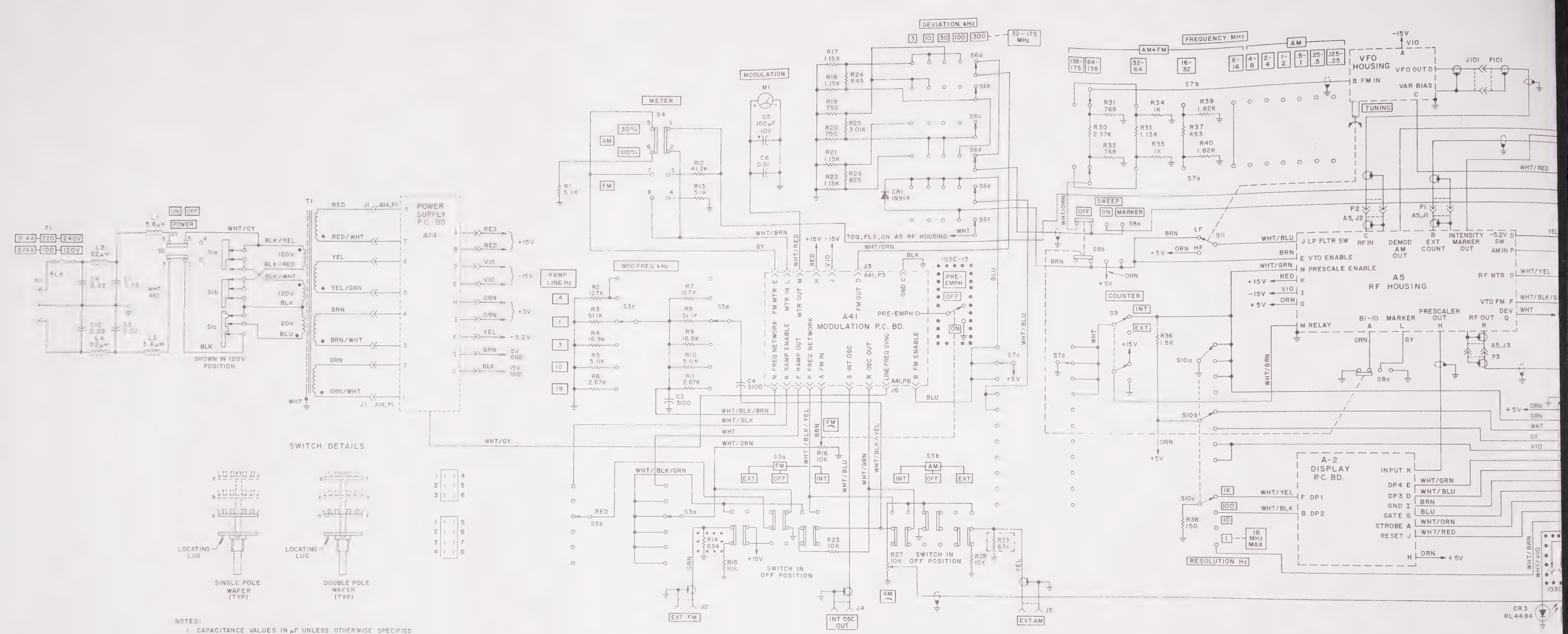
Reference	Description			BEC Part No.
	MODULATION PC BOARD (A41)			
R14	Resistor, Comp.	160 Ω 5%	AB-CB	343220
R15	Resistor, Comp.	1.8 kΩ 5%	AB-CB	343325
R16	Resistor, Comp.	6.2 kΩ 5%	AB-CB	343376
R17	Resistor, Comp.	47 kΩ 5%	AB-CB	343465
R18	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R19	Resistor, Comp.	1 MΩ 5%	AB CC	343600
R20	Resistor, Comp.	2 kΩ 5%	AB-CB	343329
R21	Resistor, Comp.	1.2 kΩ 5%	AB-CB	343308
R22	Resistor, MF	2.21 kΩ 1%	RN55D	341333
R23	Resistor, Comp.	2 kΩ 5%	AB-CB	343329
R24	Resistor, Comp.	3.9 MΩ 5%	AB CB	343657
R25	Resistor, MF	5.11 kΩ 1%	RN55D	341368
R26	Resistor, Comp.	10 kΩ 5%	AB-CB	343400
R27	Resistor, Var.	1 kΩ 10% 0.5W	Beckman 72XWR1K	311340
R28	Resistor, MF	82.5 Ω 1%	RN55D	341188
R29	Resistor, Comp.	100 Ω 5%	AB CB	343200
R30	Resistor, Comp.	100 Ω 5%	AB CB	343200
R31	Resistor, Var.	500 Ω 10% 0.5W	Beckman 72XWR500	311357
R32	Resistor, Comp.	180 Ω 5%	AB-CB	343225
R33 through R36	Resistor, MF	10 kΩ 1%	RN55D	341400
R37	Resistor, MF	590 Ω 1%	RN55D	341274
	MISCELLANEOUS			
J1401	Connector		Amphenol 143 022 01	479173
FL8*	RFI Filter Ass'y	8 (GRY)	Boonton Electronics	103123-1

*Model 103D Only

SECTION VI
SCHEMATICS

NOTE

Unless otherwise specified, the schematic diagrams in this section apply to both the Model 103C and the Model 103D.


POWER SUPPLY P.C. BD A14
A41 MODULATION P.C. BD.
A5 RF HOUSING
A-2 DISPLAY P.C. BD.
VFO HOUSING
SHOWN IN 120V POSITION
SWITCH DETAILS
SINGLE POLE WAFER (TYP.)
DOUBLE POLE WAFER (TYP.)
LOCATING LUG
SWITCH IN OFF POSITION
NOTES:
1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED
2. RESISTANCE VALUES IN OHMS
3. LAST NUMBERS USED: R46 C11 S12 J16 P12
4. EXTERNAL MARKINGS
5. SIGNIFIES OPTIONAL COMPONENTS.
6. NOT USED ON 103A-06, OPT. HIGH IMP. FM INPUT
7. NOT USED ON 103A-05, OPT. HIGH IMP. AM INPUT
8. NUMBERS NOT USED: P4, P5, P7, P8, P13 J8, J14, R43, R46

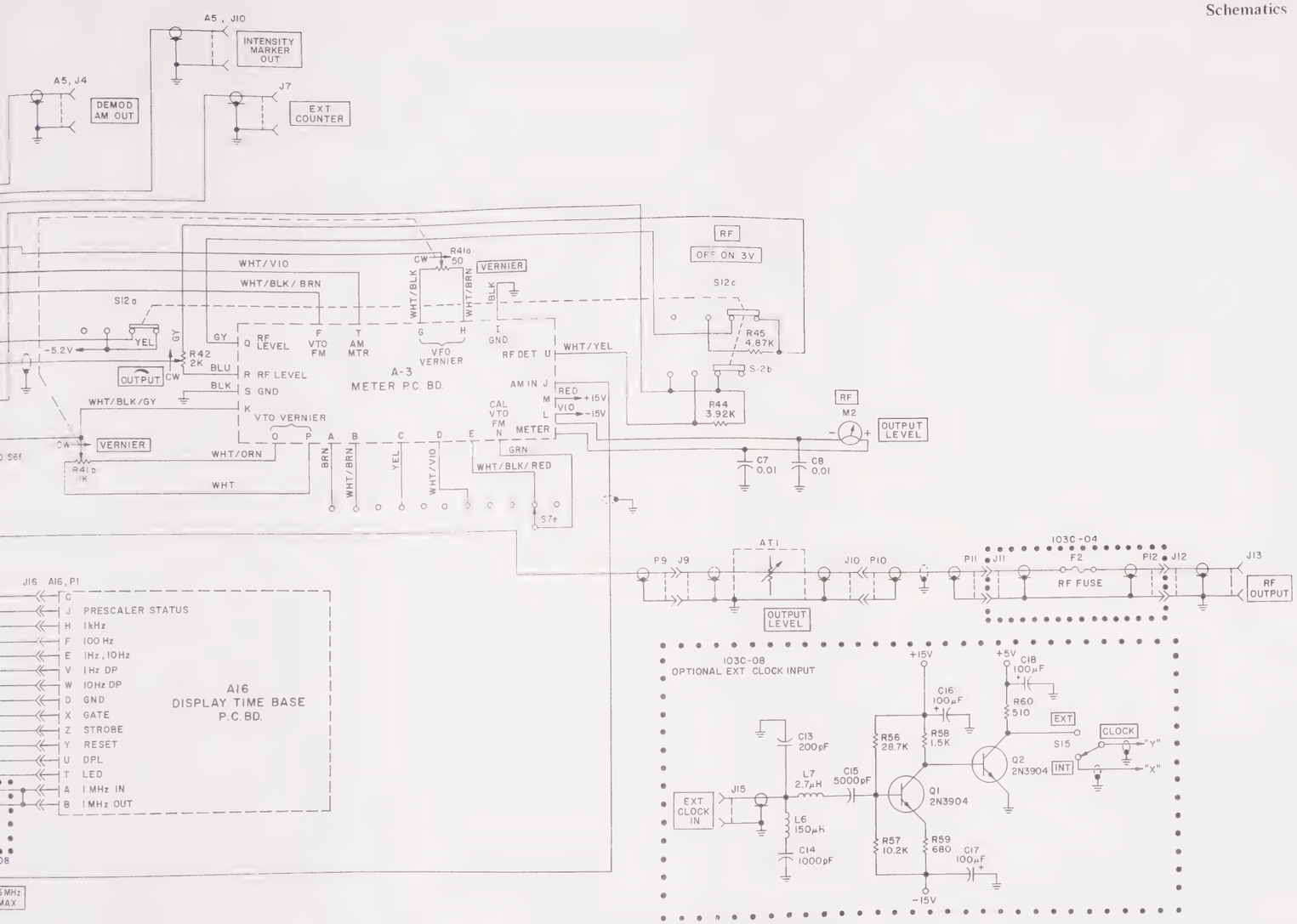
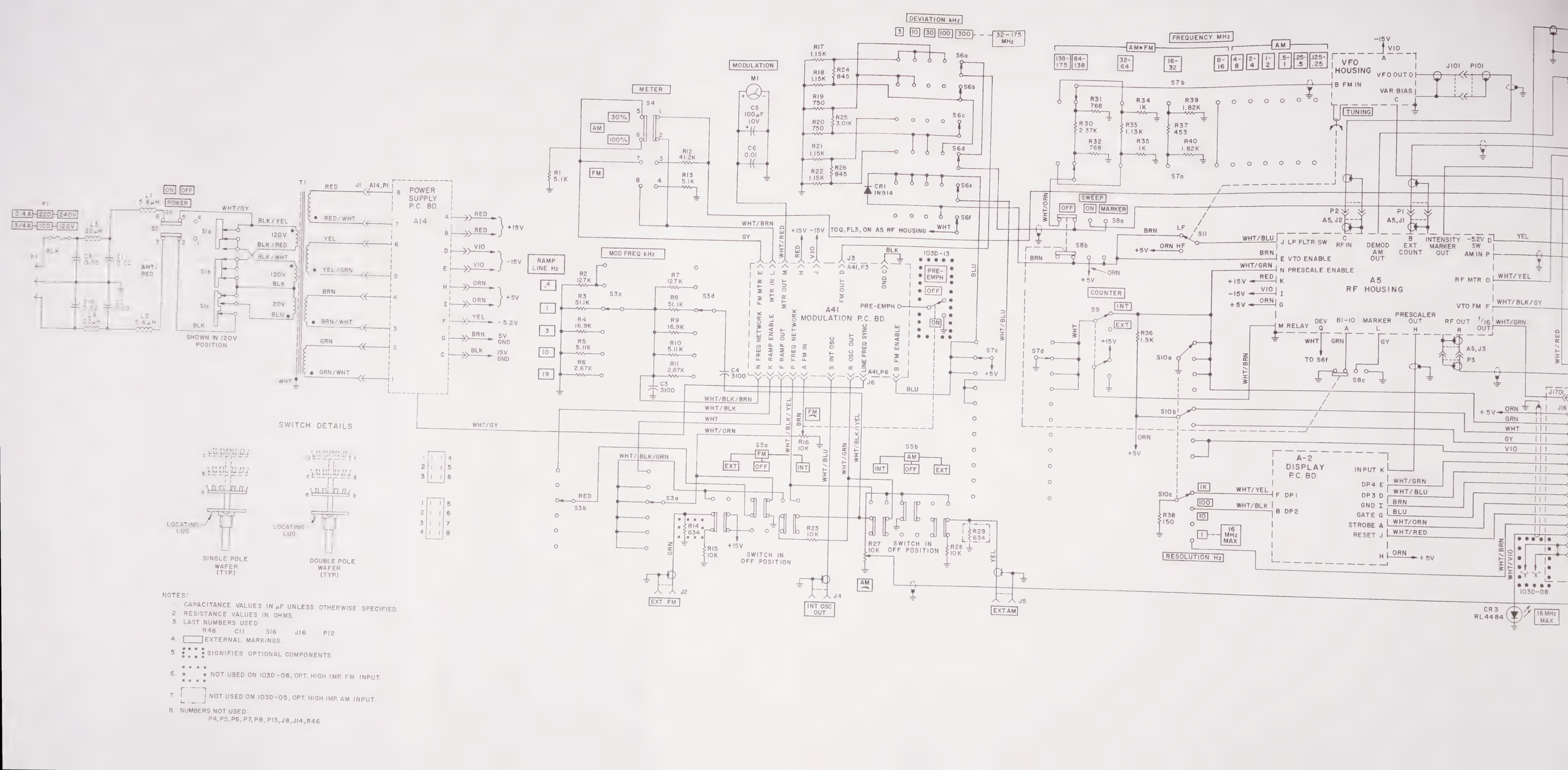


Figure 6-1. Main Frame A1, Model 103C, Schematic Diagram (Sheet 1 of 2)


SWITCH DETAILS
SINGLE POLE WAFER (TYP.)
DOUBLE POLE WAFER (TYP.)
LOCATING LUG
NOTES:
1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED:
R46 C11 S16 J16 P12
4. EXTERNAL MARKINGS.
5. SIGNIFIES OPTIONAL COMPONENTS.
6. NOT USED ON 103D-06, OPT. HIGH IMP. FM INPUT.
7. NOT USED ON 103D-05, OPT. HIGH IMP. AM INPUT.
8. NUMBERS NOT USED:
P4, P5, P6, P7, P8, P13, J8, J14, R46
POWER SUPPLY P.C. BD. A14
SHOWN IN 120V POSITION
A41 MODULATION P.C. BD.
A5 RF HOUSING
A-2 DISPLAY P.C. BD.
VFO HOUSING
TUNING
SWEEP
COUNTER
RESOLUTION Hz
SWITCH IN OFF POSITION
DEVIATION kHz
MODULATION
METER
MOD FREQ kHz
RAMP LINE Hz
FREQUENCY MHz
PRE-EMPH
EXT FM
INT OSC OUT
EXT AM
16 MHz MAX
CR3 RL4484
103D-08
103D-13

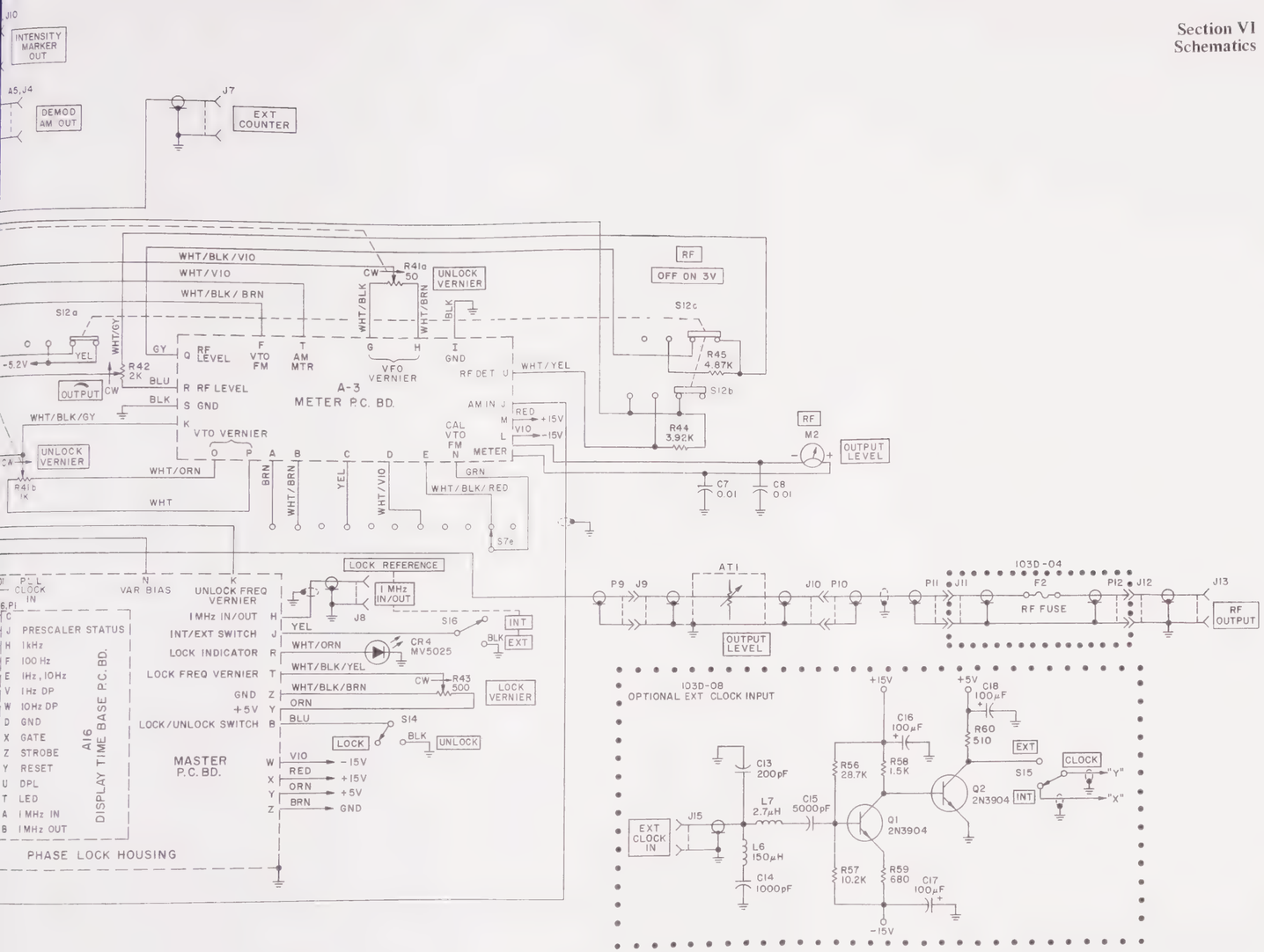
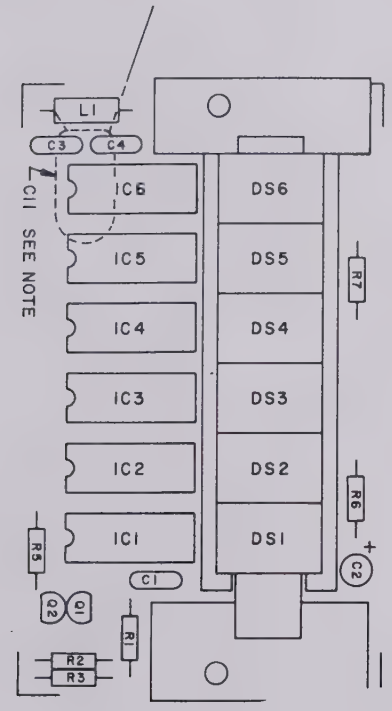
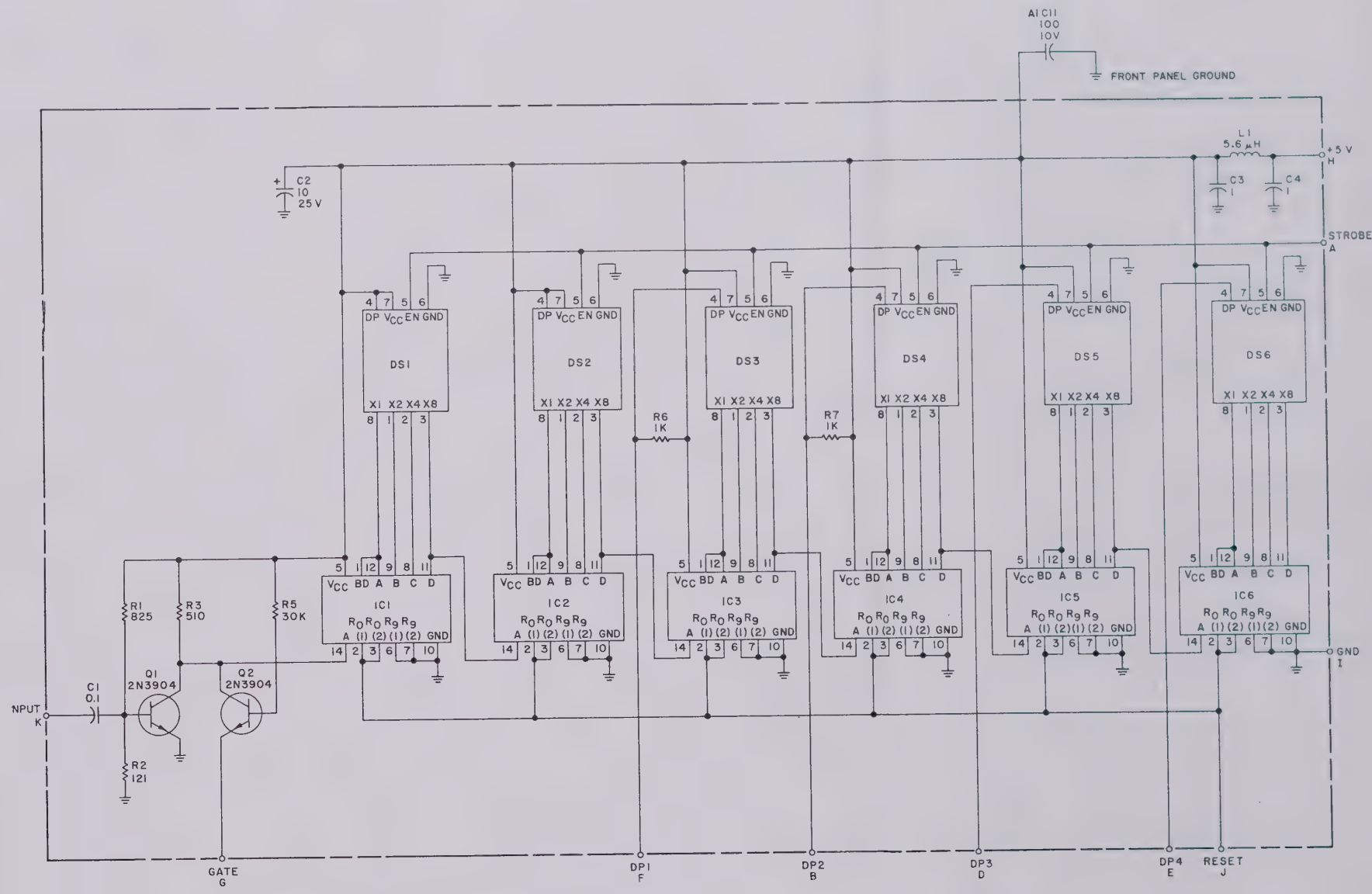


Figure 6-1. Main Frame A1, Model 103D, Schematic Diagram (Sheet 2 of 2)



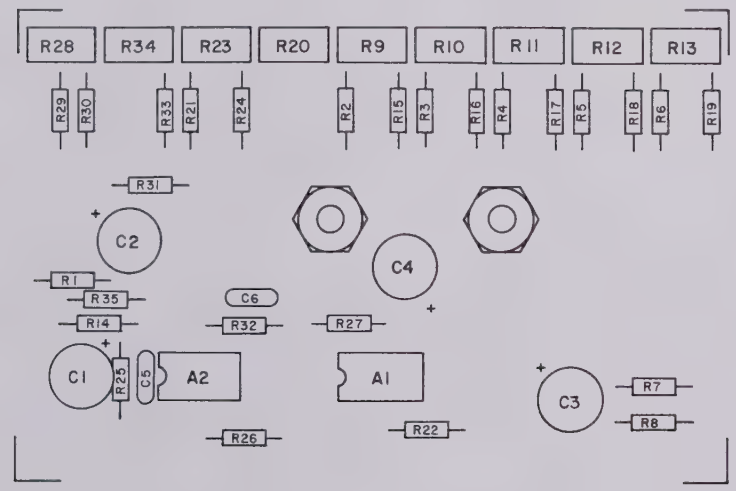
D830853D

NOTE:
CII CONNECTED BETWEEN DISPLAY PRINTED CIRCUIT BOARD AND FRONT PANEL GROUND.

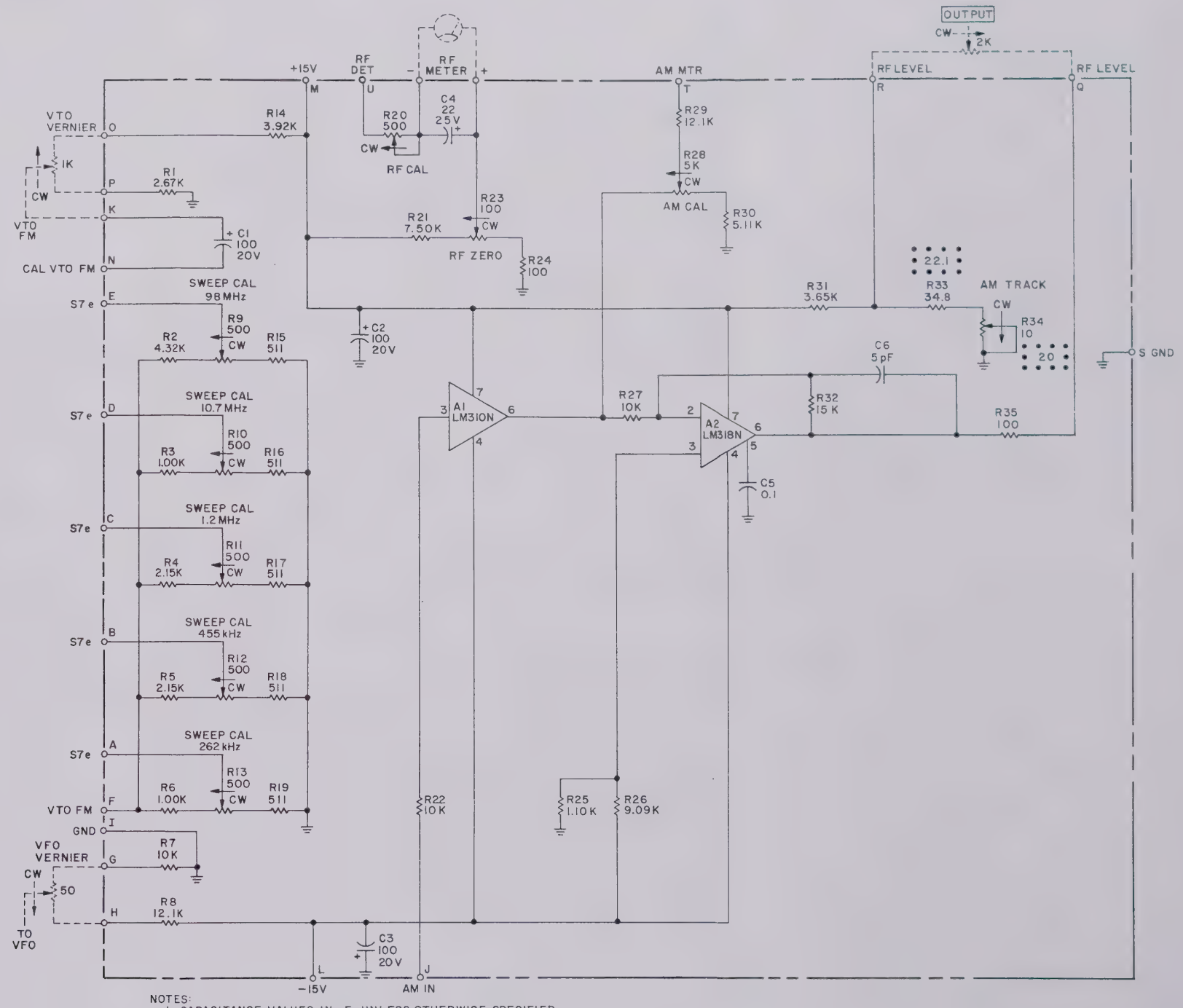


NOTES:
1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. INTEGRATED CIRCUITS ARE TYPE SN7490N, UNLESS OTHERWISE SPECIFIED.
4. NUMERIC DISPLAYS ARE TYPE HP5082-7357, UNLESS OTHERWISE SPECIFIED.
5. LAST NUMBERS USED:
   DS6, IC6, R7,
6. NUMBERS NOT USED:
   R4, C5
7. AICII IS LISTED IN THE SUB PANEL PARTS LIST.

Figure 6-2. Display PCB A2, Schematic Diagram

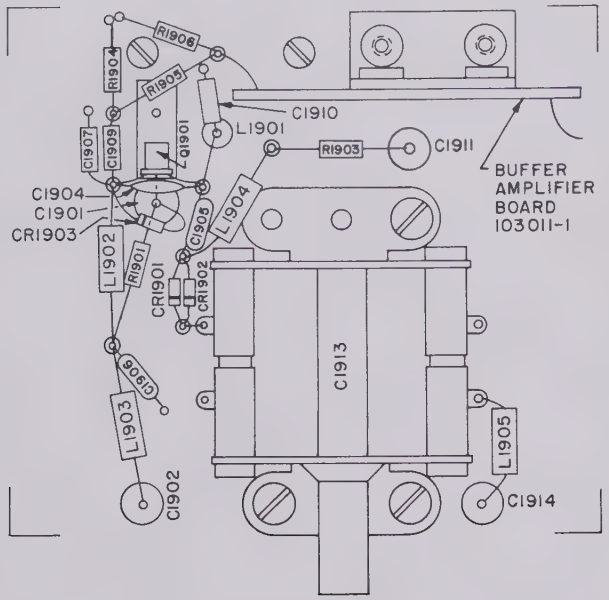


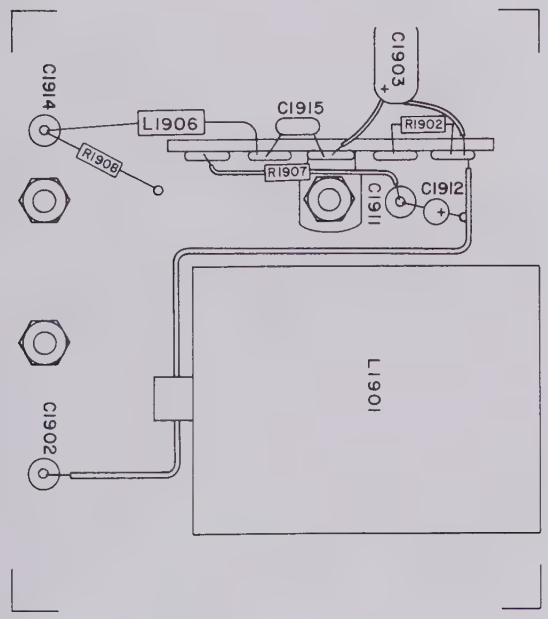
830853G



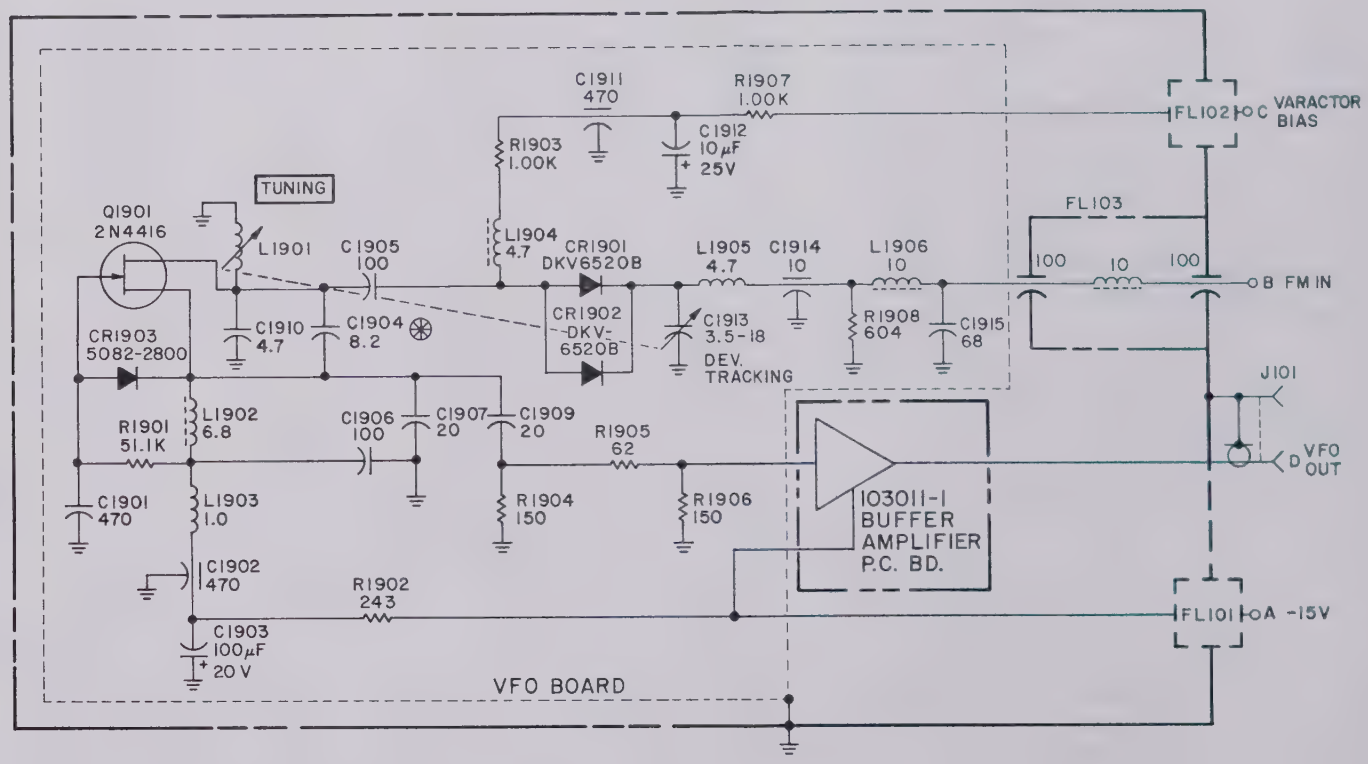
NOTES:
1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. ▭ EXTERNAL MARKINGS.
4. LAST NUMBERS USED:
   C6, R35
5. • • • • • THIS VALUE FOR 103C & 103D.
   • • • •

Figure 6-3. Meter PCB A3, Schematic Diagram



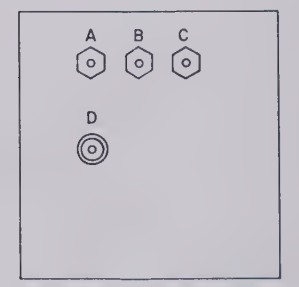


C830853F



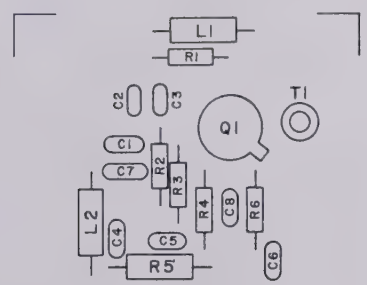
NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. INDUCTANCE VALUES IN μH, UNLESS OTHERWISE SPECIFIED.
4. ▭ EXTERNAL MARKINGS.
5. LAST NUMBERS USED:
   C1915, L1906, R1908
6. NUMBERS NOT USED:
   C1908
7. ⊛ FACTORY SELECTED.

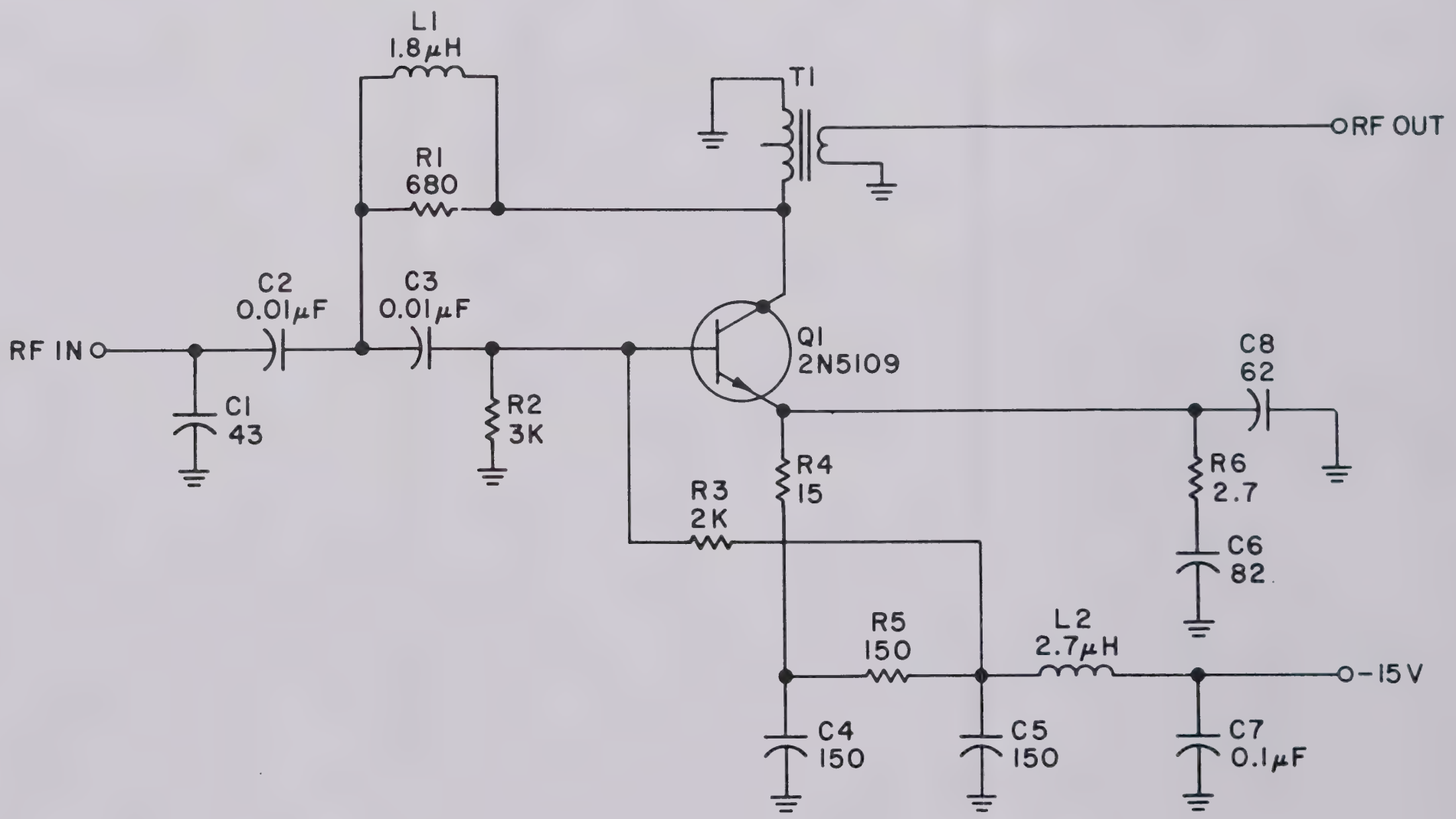


VFO HOUSING IDENTIFICATION

Figure 6-4. VFO, Schematic Diagram



B830853A



NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED:
   R6, C8

Figure 6-5. Buffer Amplifier PCB A4, Schematic Diagram

NOTES:

NUMBERS NOT USED:

A13P1(9)-W8J9(9)
W8J17(19)-A11P1(19)
A11J1(20)-W14P6(20)
P7(21)-W15J18(21)
A11P2(22)-W15J19(22)
W1P1(1)-W1J1(1)

RF HOUSING IDENTIFICATION
(TOP HALF)

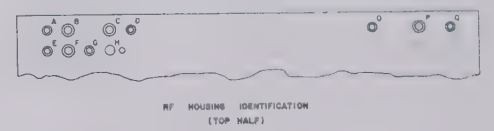
NOTES:

1. NUMBERS NOT USED:
P11(29)W19 J26(29)
J28(32)W21 P13(32)

RF HOUSING IDENTIFICATION
(BOTTOM HALF)

Figure 6-6. RF Housing A5, Model 103C, Schematic Diagram

NOTE:
1. NUMBERS NOT USED:
W1P1(1) W1J1(1)
A6P3(12) W10J11(12)



NOTES:
1. NUMBERS NOT USED:
P11(29)W19 J26(29)
J28(32)W21 P13(32)

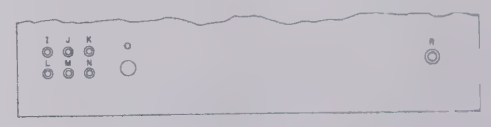
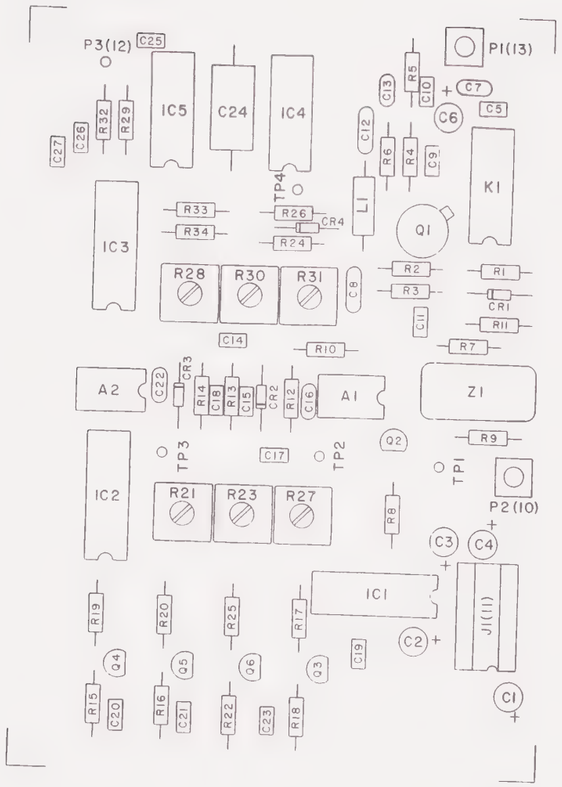
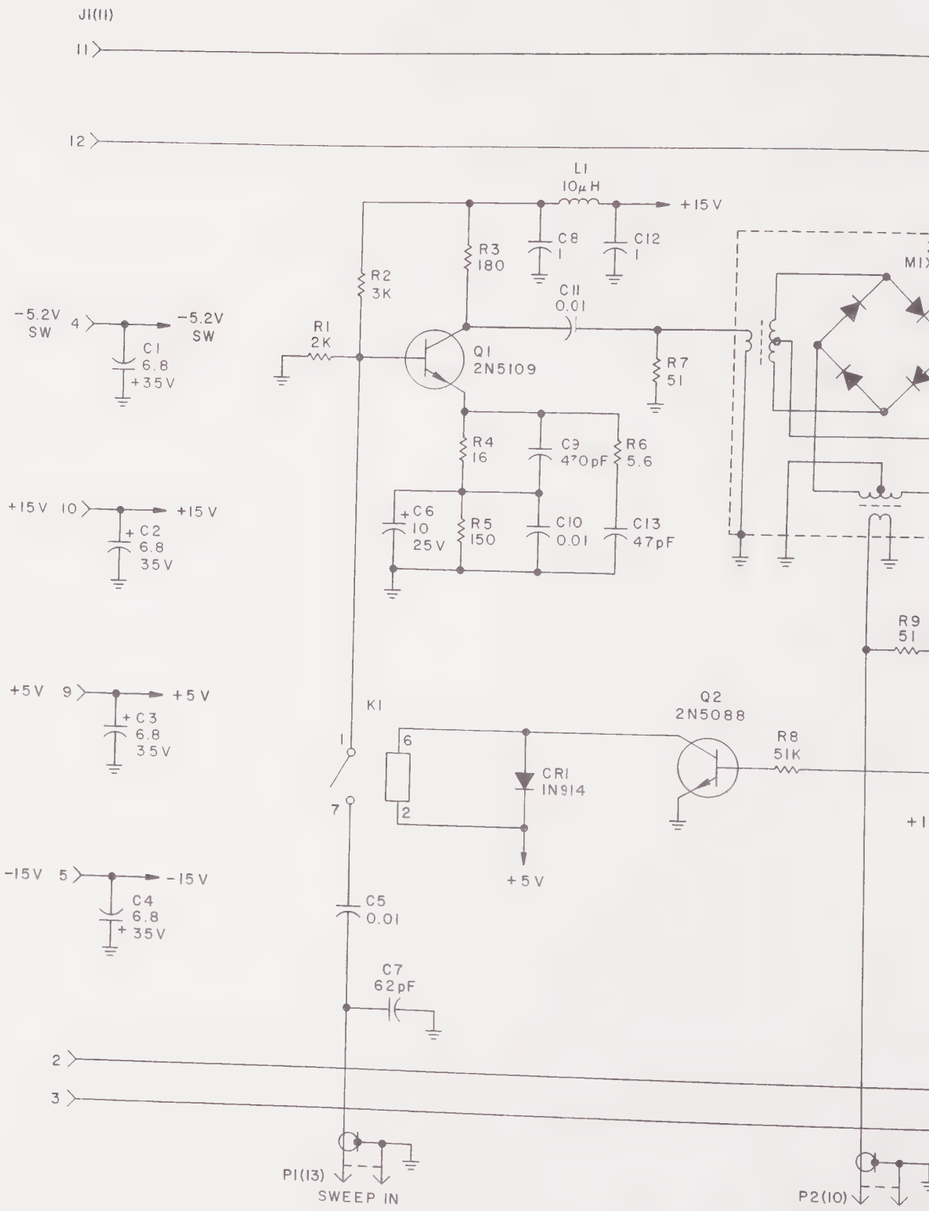


Figure 6-7. RF Housing A5, Model 103D, Schematic Diagram

E830991D



J1(11)
CONNECTS TO
A5W9P4(11) ON
RF HOUSING SCHEMATIC



NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED:
   R34 C27 Q6 IC5

P1(13)
CONNECTS TO
A5W11J14(13) ON
RF HOUSING SCHEMATIC

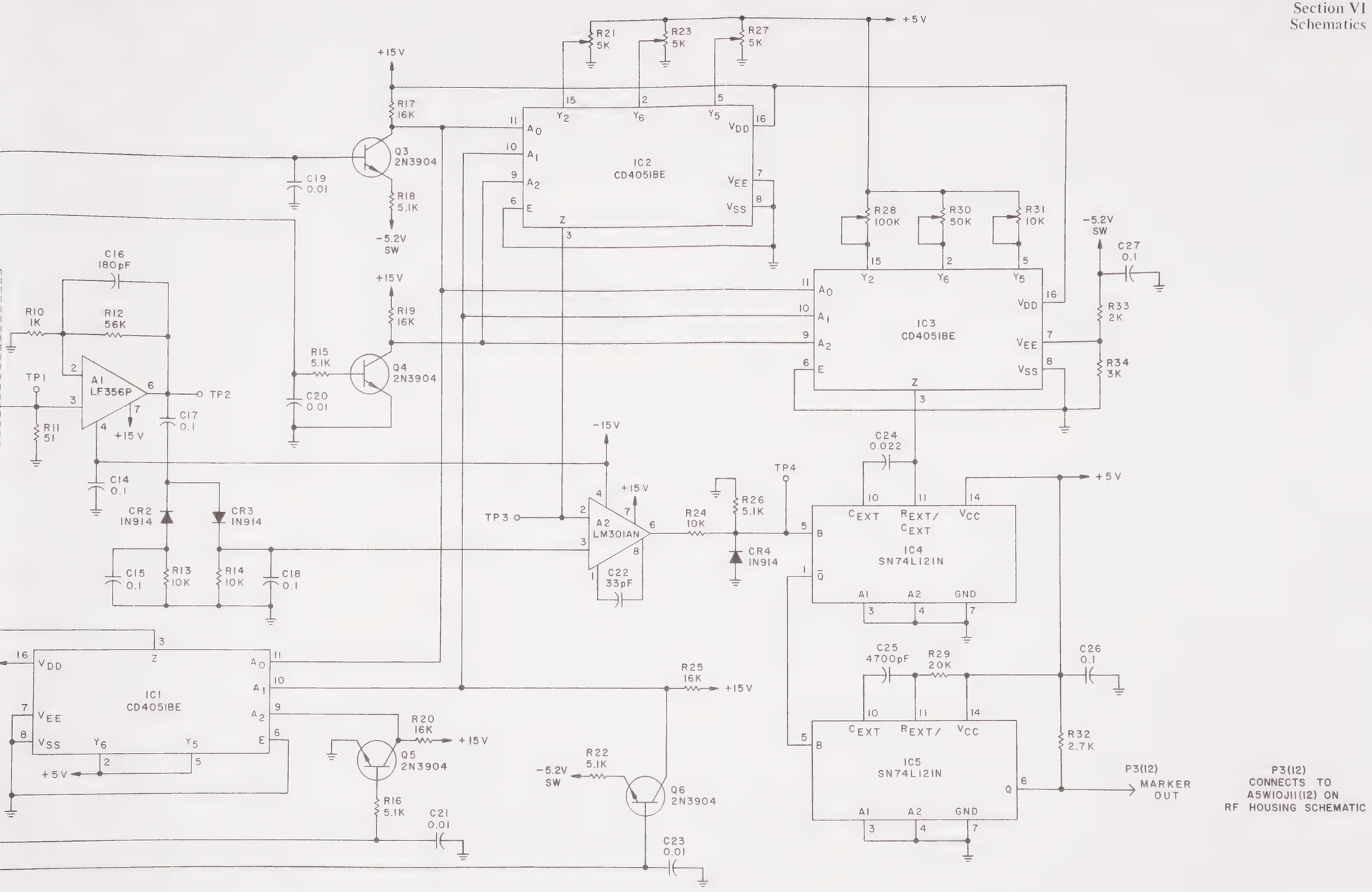
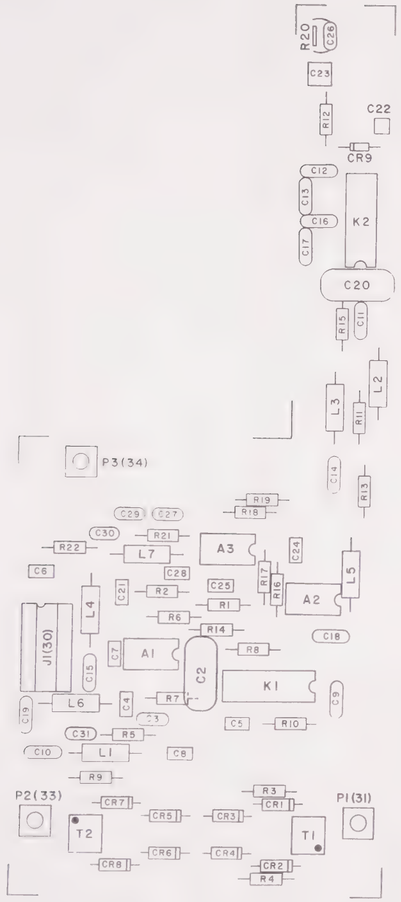
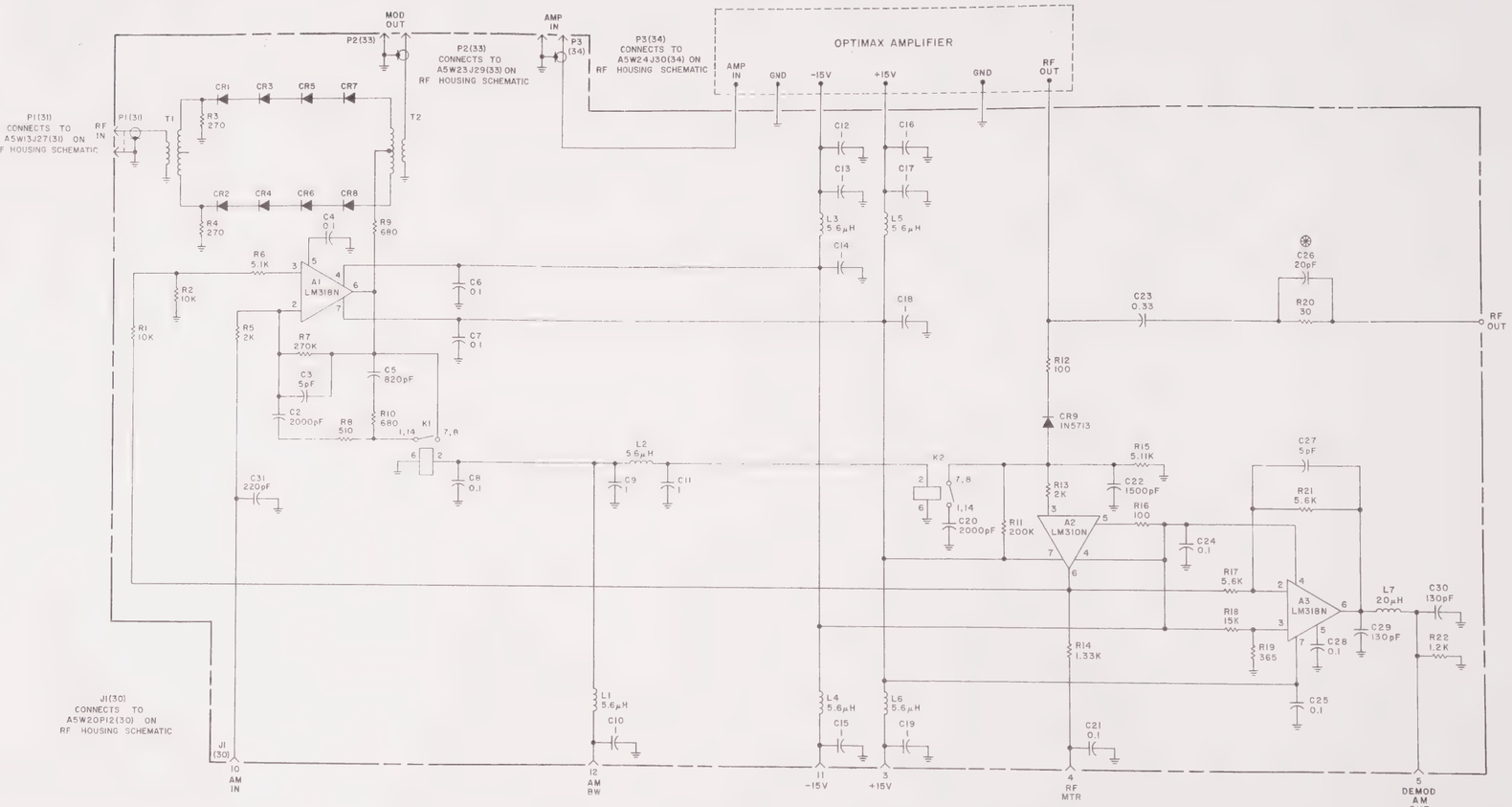


Figure 6-8. Intensity Marker PCB A6, Schematic Diagram

E83099IF



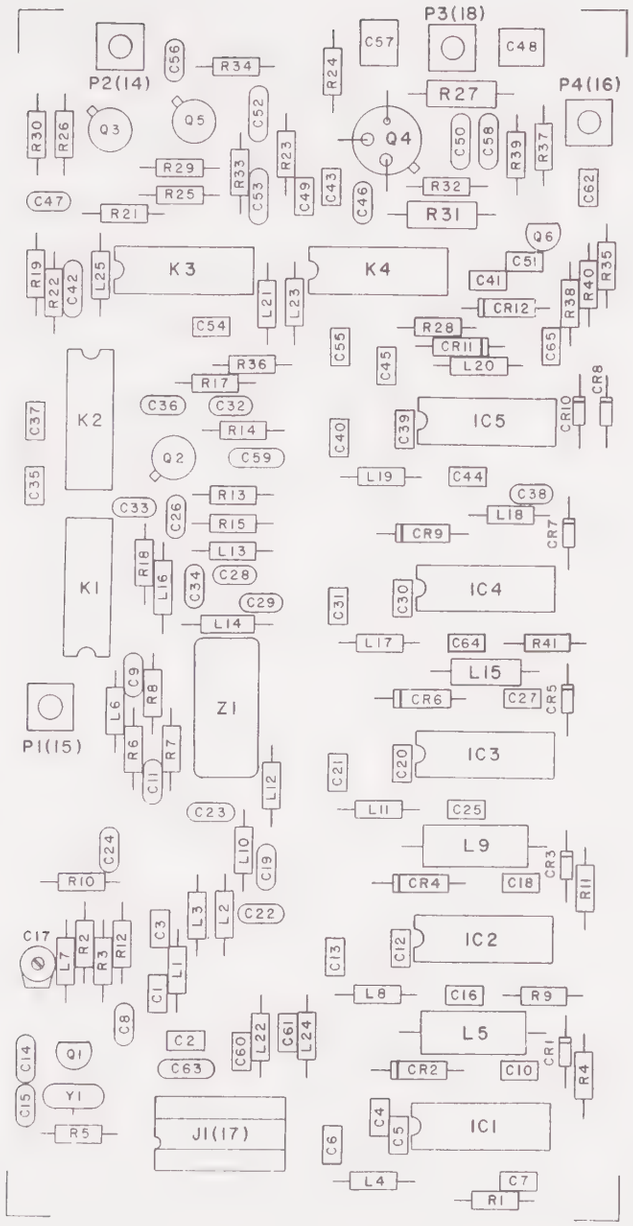


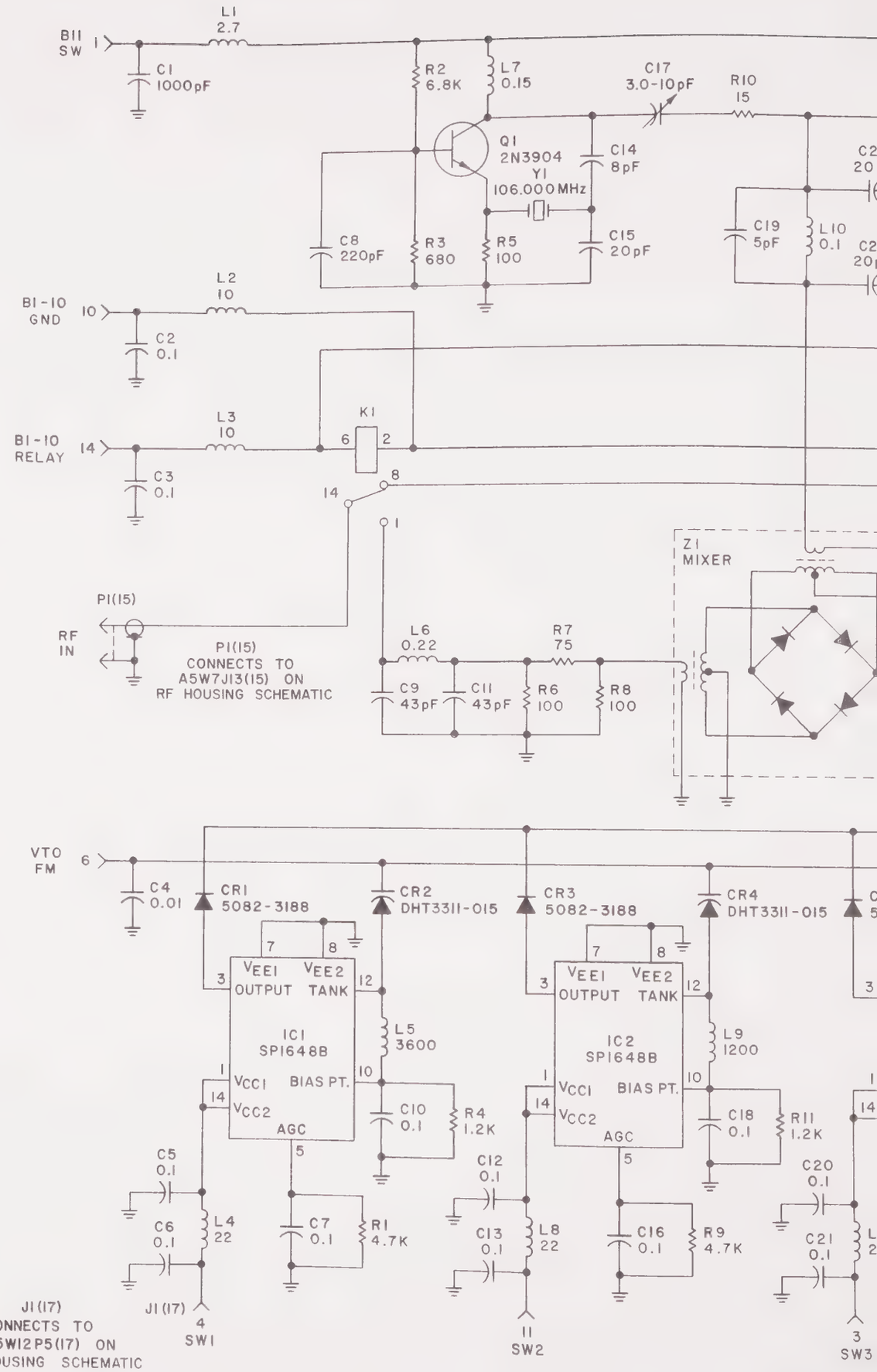
NOTES:

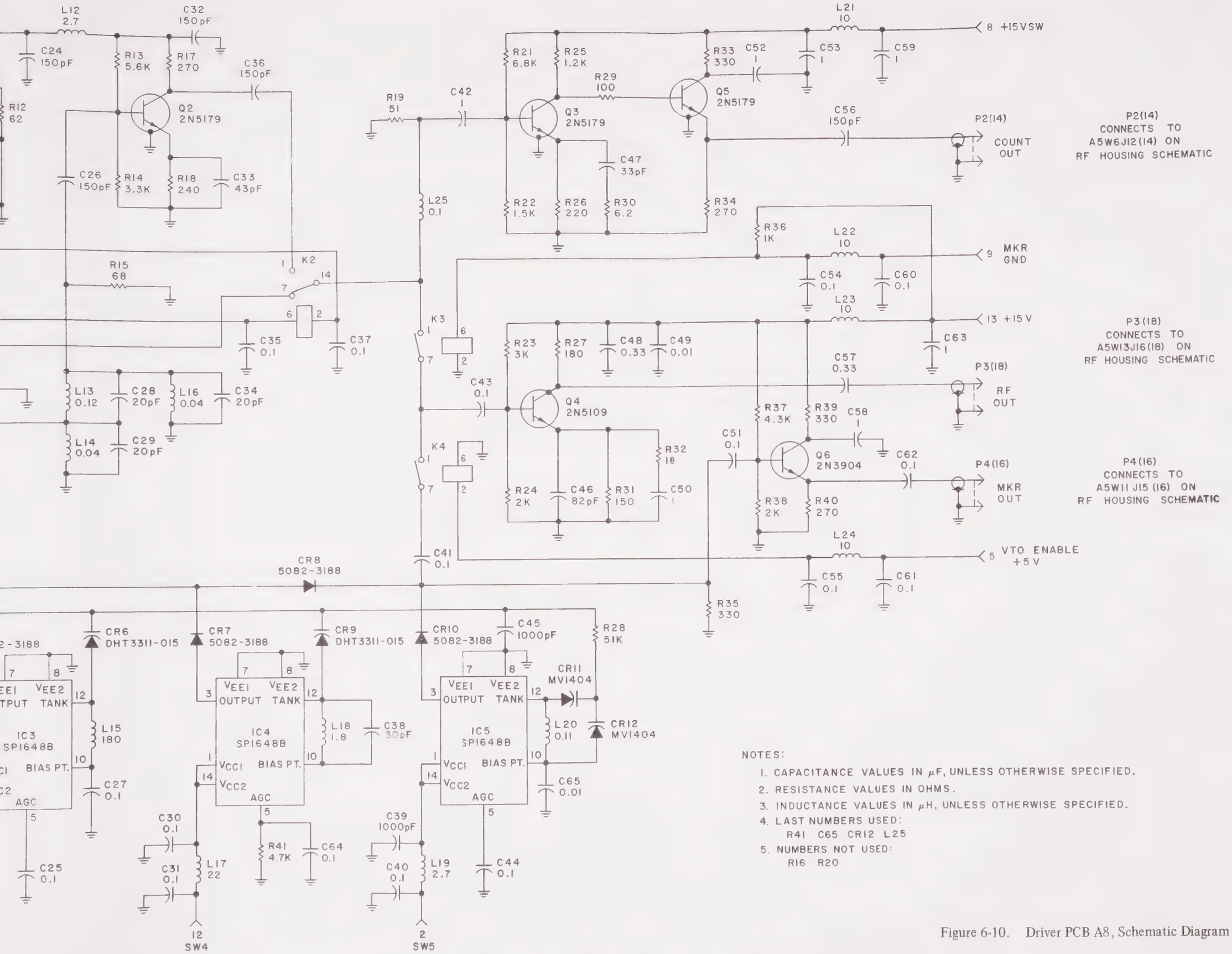
1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS
3. ⊛ SELECTED VALUE
4. LAST NUMBERS USED:
   C31 , R22 , CR9 , L7
5. CR1 THRU CR8 TO BE TYPE PMS 702-08 UNLESS OTHERWISE SPECIFIED.
6. NUMBERS NOT USED
   C1

Figure 6-9. Output PCB A7, Schematic Diagram

E830991E


P3(18)
P2(14)
P4(16)
P1(15)
J1(17)
K1
K2
K3
K4
Z1
IC1
IC2
IC3
IC4
IC5
L1
L2
L3
L4
L5
L6
L7
L8
L9
L10
L11
L12
L13
L14
L15
L16
L17
L18
L19
L20
L21
L22
L23
L24
L25
Q1
Q2
Q3
Q4
Q5
Q6
Y1
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR9
CR10
CR11
CR12
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R17
R18
R19
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
R31
R32
R33
R34
R35
R36
R37
R38
R39
R40
R41
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C31
C32
C33
C34
C35
C36
C37
C38
C39
C40
C41
C42
C43
C44
C45
C46
C47
C48
C49
C50
C51
C52
C53
C54
C55
C56
C57
C58
C59
C60
C61
C62
C63
C64
C65


B11
SW
1
L1
2.7
C1
1000pF
R2
6.8K
L7
0.15
C17
3.0-10pF
R10
15
Q1
2N3904
Y1
106.000MHz
C14
8pF
C8
220pF
R3
680
R5
100
C15
20pF
C19
5pF
L10
0.1
B1-10
GND
10
L2
10
C2
0.1
B1-10
RELAY
14
L3
10
C3
0.1
K1
6
2
8
14
1
P1(15)
RF
IN
P1(15)
CONNECTS TO
A5W7J13(15) ON
RF HOUSING SCHEMATIC
L6
0.22
R7
75
C9
43pF
C11
43pF
R6
100
R8
100
Z1
MIXER
VTO
FM
6
C4
0.01
CR1
5082-3188
CR2
DHT3311-015
CR3
5082-3188
CR4
DHT3311-015
7
8
3
VEE1
OUTPUT
VEE2
TANK
12
IC1
SP1648B
IC2
SP1648B
1
14
VCC1
VCC2
BIAS PT.
AGC
10
5
L5
3600
L9
1200
C10
0.1
R4
1.2K
C18
0.1
R11
1.2K
C5
0.1
C6
0.1
L4
22
C7
0.1
R1
4.7K
C12
0.1
C13
0.1
L8
22
C16
0.1
R9
4.7K
C20
0.1
C21
0.1
J1(17)
CONNECTS TO
A5W12P5(17) ON
RF HOUSING SCHEMATIC
J1(17)
4
SW1
11
SW2
3
SW3



P2(14) CONNECTS TO A5W6J12(14) ON RF HOUSING SCHEMATIC

P3(18) CONNECTS TO A5W13J16(18) ON RF HOUSING SCHEMATIC

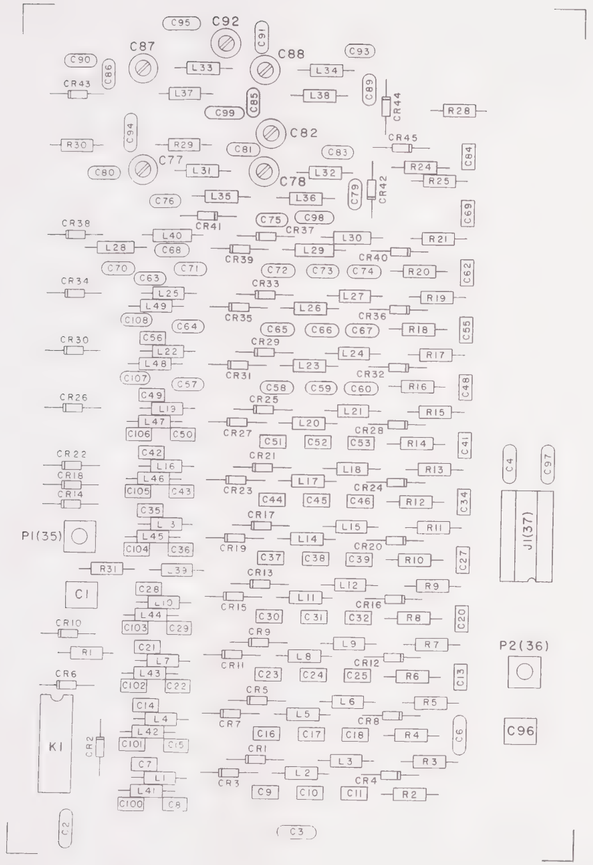
P4(16) CONNECTS TO A5W11 J15 (16) ON RF HOUSING SCHEMATIC

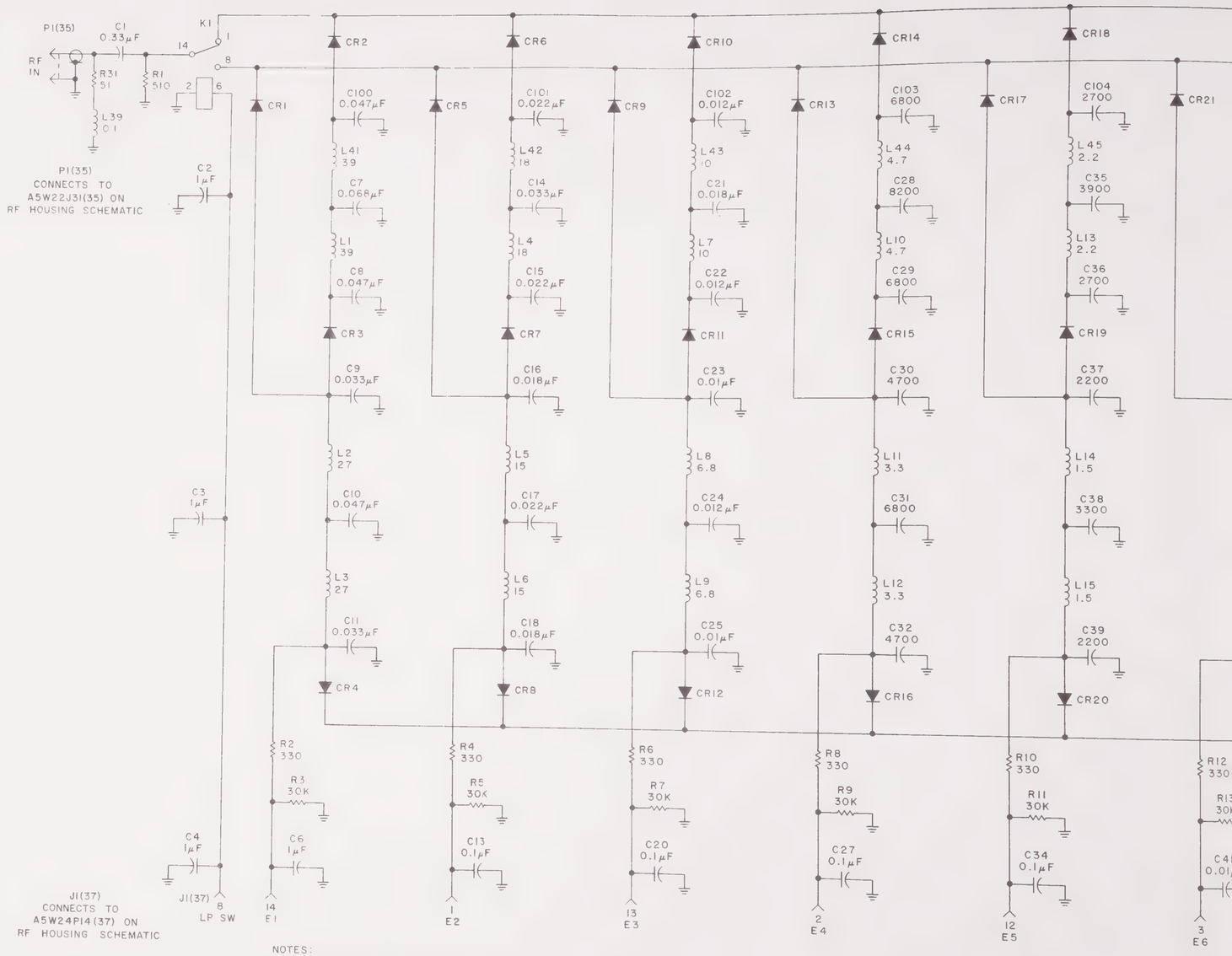
NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. INDUCTANCE VALUES IN μH, UNLESS OTHERWISE SPECIFIED.
4. LAST NUMBERS USED:
   R41 C65 CR12 L25
5. NUMBERS NOT USED:
   R16 R20

Figure 6-10. Driver PCB A8, Schematic Diagram

J830991E





NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. ALL DIODES TO BE TYPE 5082-3188, UNLESS OTHERWISE SPECIFIED.
4. INDUCTANCE VALUES IN µH, UNLESS OTHERWISE SPECIFIED.
5. LAST NUMBERS USED:
   R31, C108, CR45, L49
6. NUMBERS NOT USED:
   R22, R23, R26, R27
   C5, C12, C19, C26, C33,
   C40, C47, C54, C61

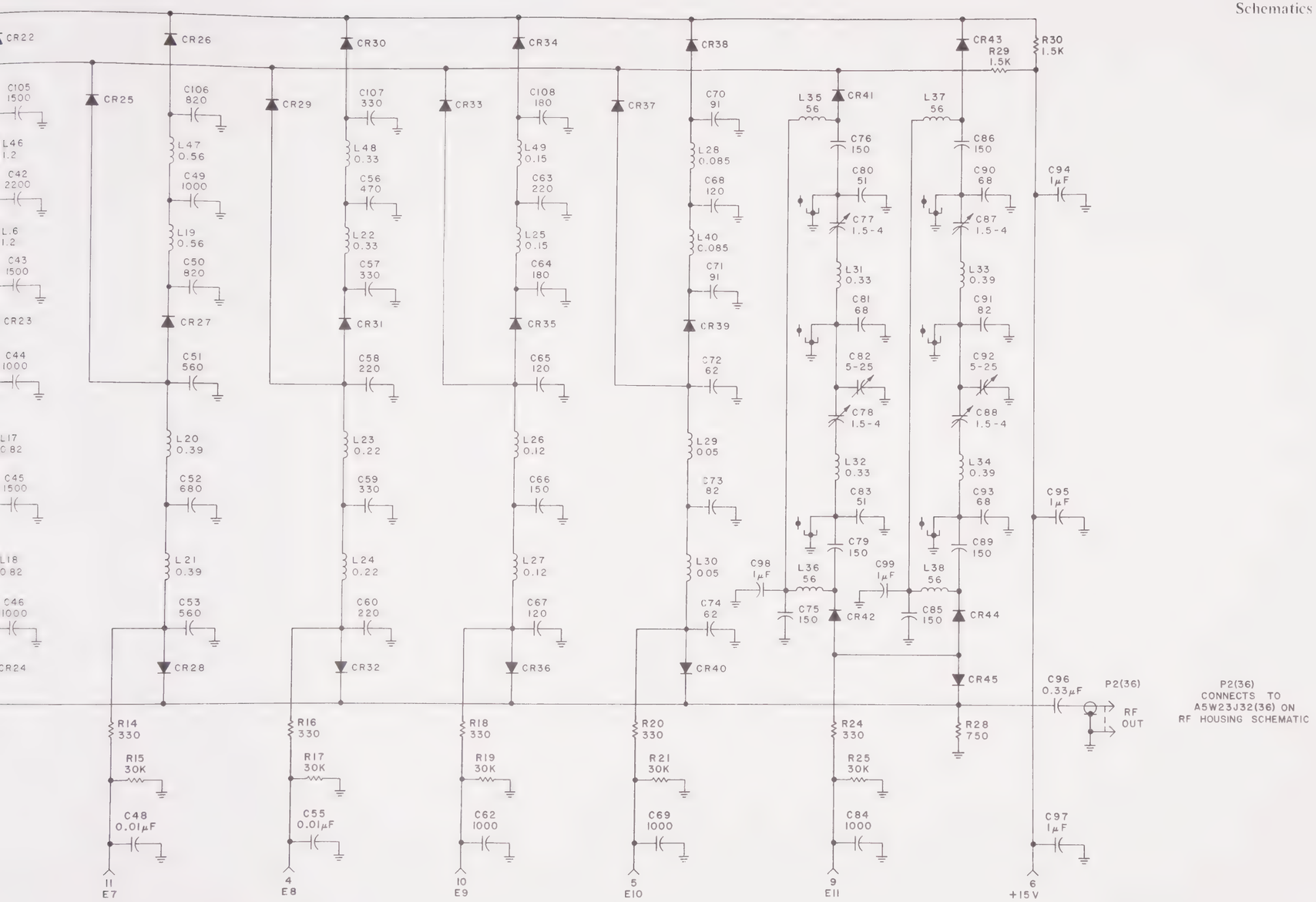


Figure 6-11. HF Filter PCB A9, Schematic Diagram

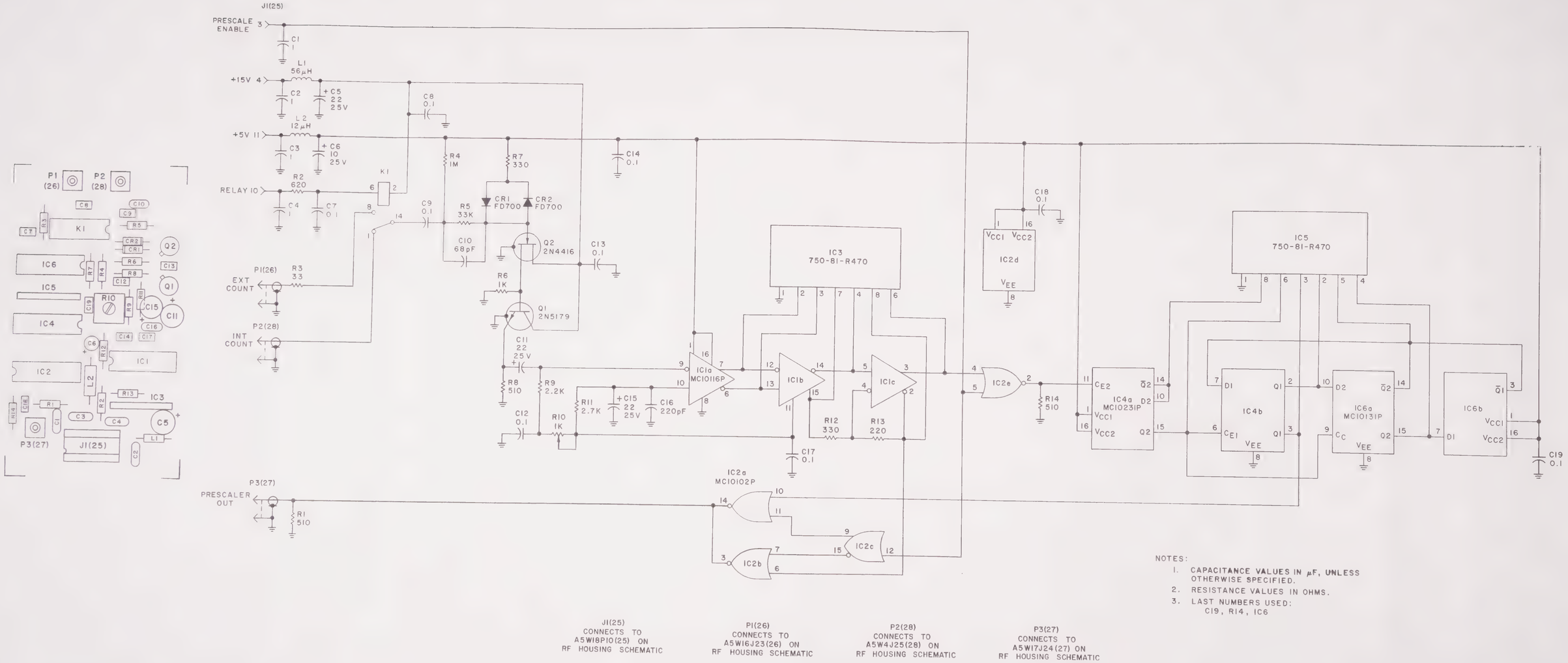
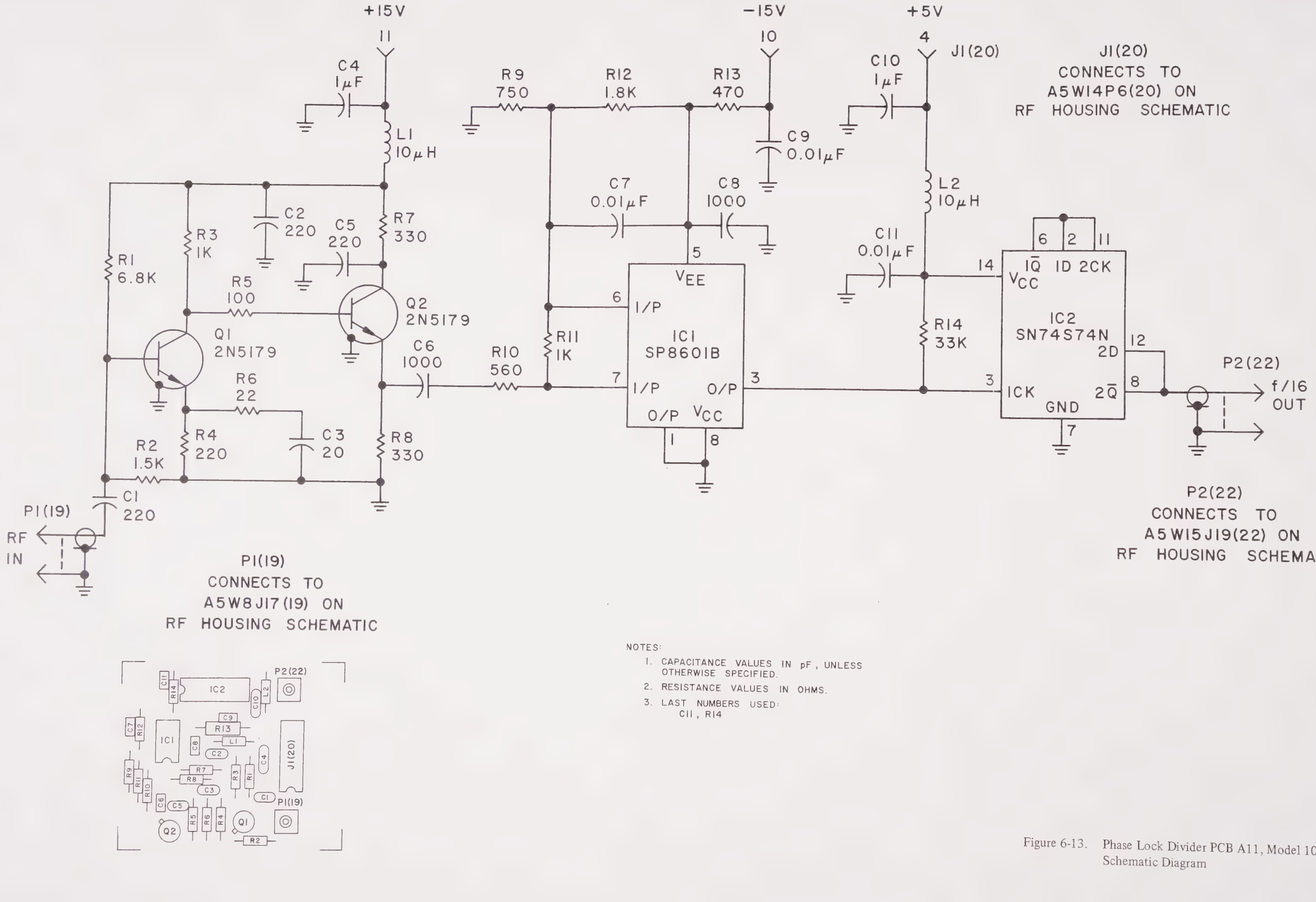


Figure 6-12. Prescaler PCB A10, Schematic Diagram



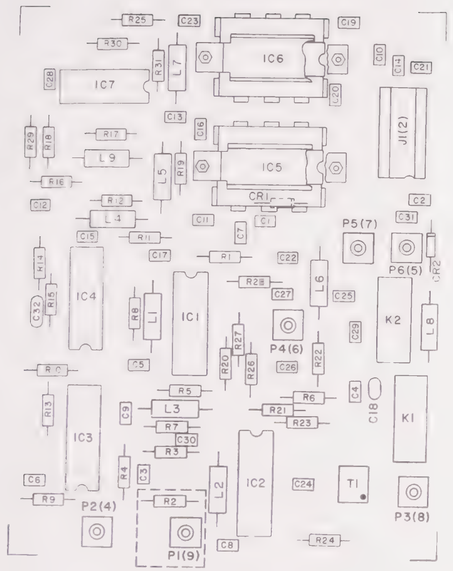
NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED:
   C11, R14

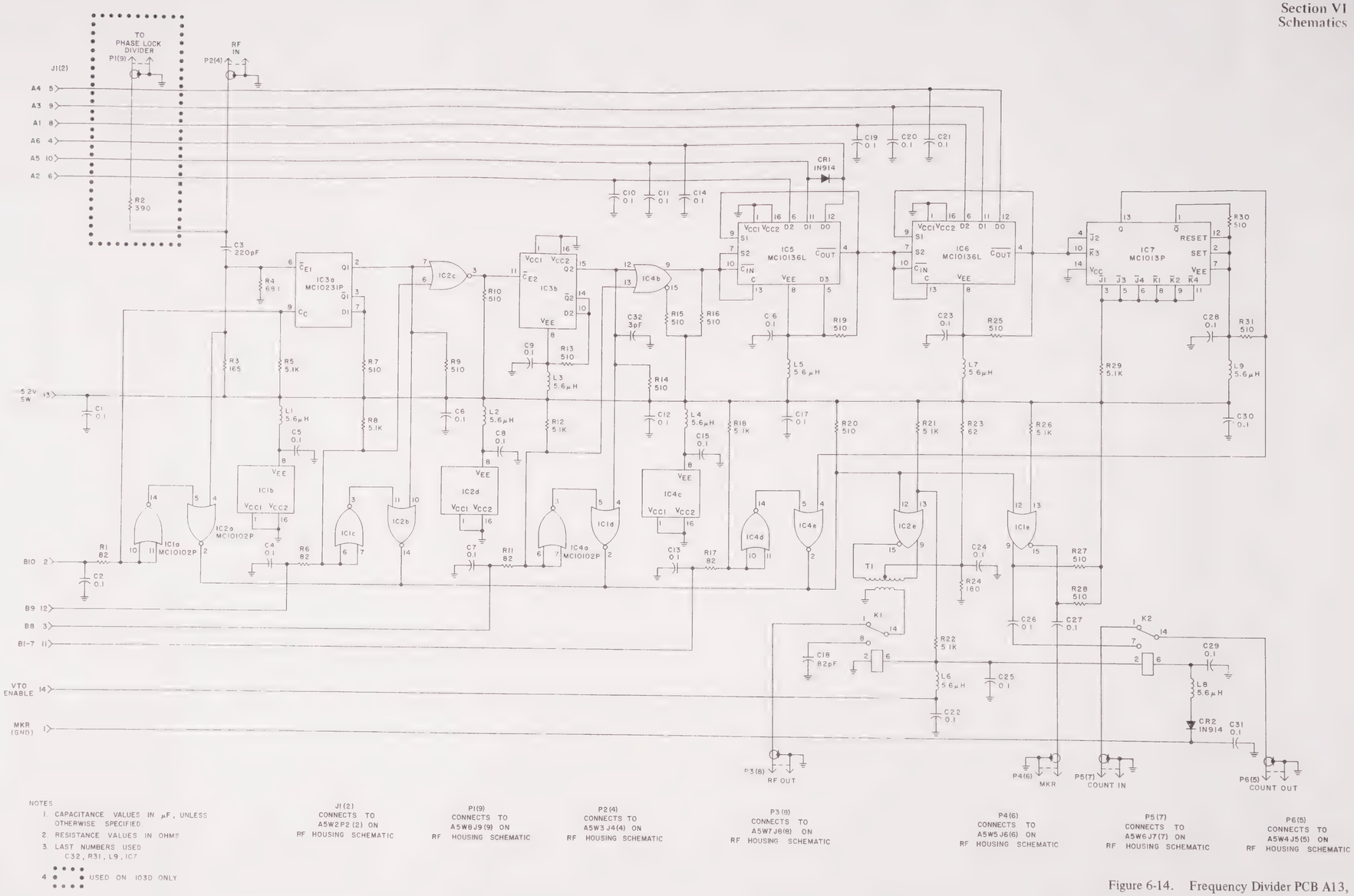
C830992C

Figure 6-13. Phase Lock Divider PCB A11, Model 103D, Schematic Diagram

E830991C



NOTE:
1. R2 & P1(9) USED ON 103D ONLY.



NOTES
1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS
3. LAST NUMBERS USED C32, R31, L9, IC7
4. ● ● ● ● USED ON 103D ONLY

J1(2) CONNECTS TO A5W2P2(2) ON RF HOUSING SCHEMATIC

P1(9) CONNECTS TO A5W8J9(9) ON RF HOUSING SCHEMATIC

P2(4) CONNECTS TO A5W3J4(4) ON RF HOUSING SCHEMATIC

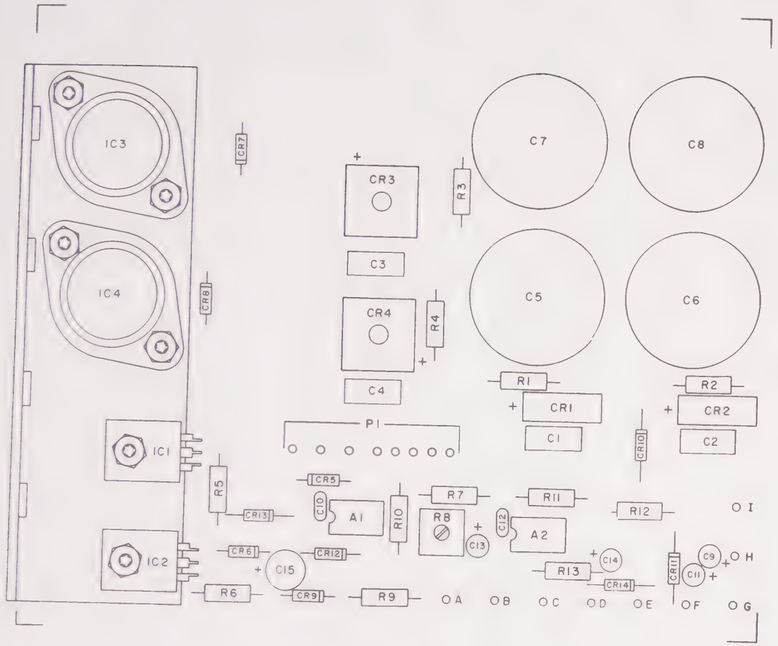
P3(8) CONNECTS TO A5W7J6(8) ON RF HOUSING SCHEMATIC

P4(6) CONNECTS TO A5W5J6(6) ON RF HOUSING SCHEMATIC

P5(7) CONNECTS TO A5W6J7(7) ON RF HOUSING SCHEMATIC

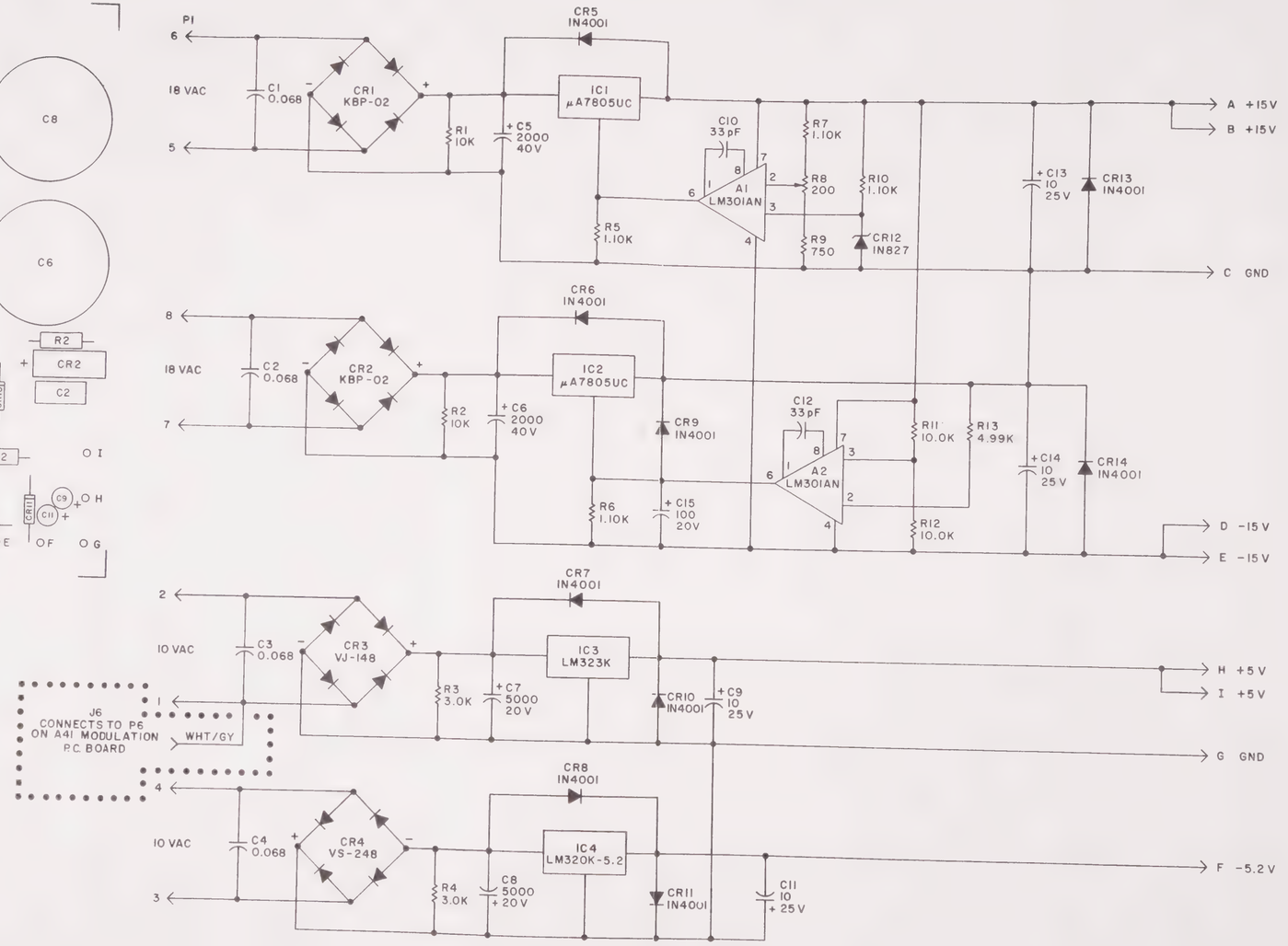
P6(5) CONNECTS TO A5W4J5(5) ON RF HOUSING SCHEMATIC

Figure 6-14. Frequency Divider PCB A13, Schematic Diagram



NOTES:

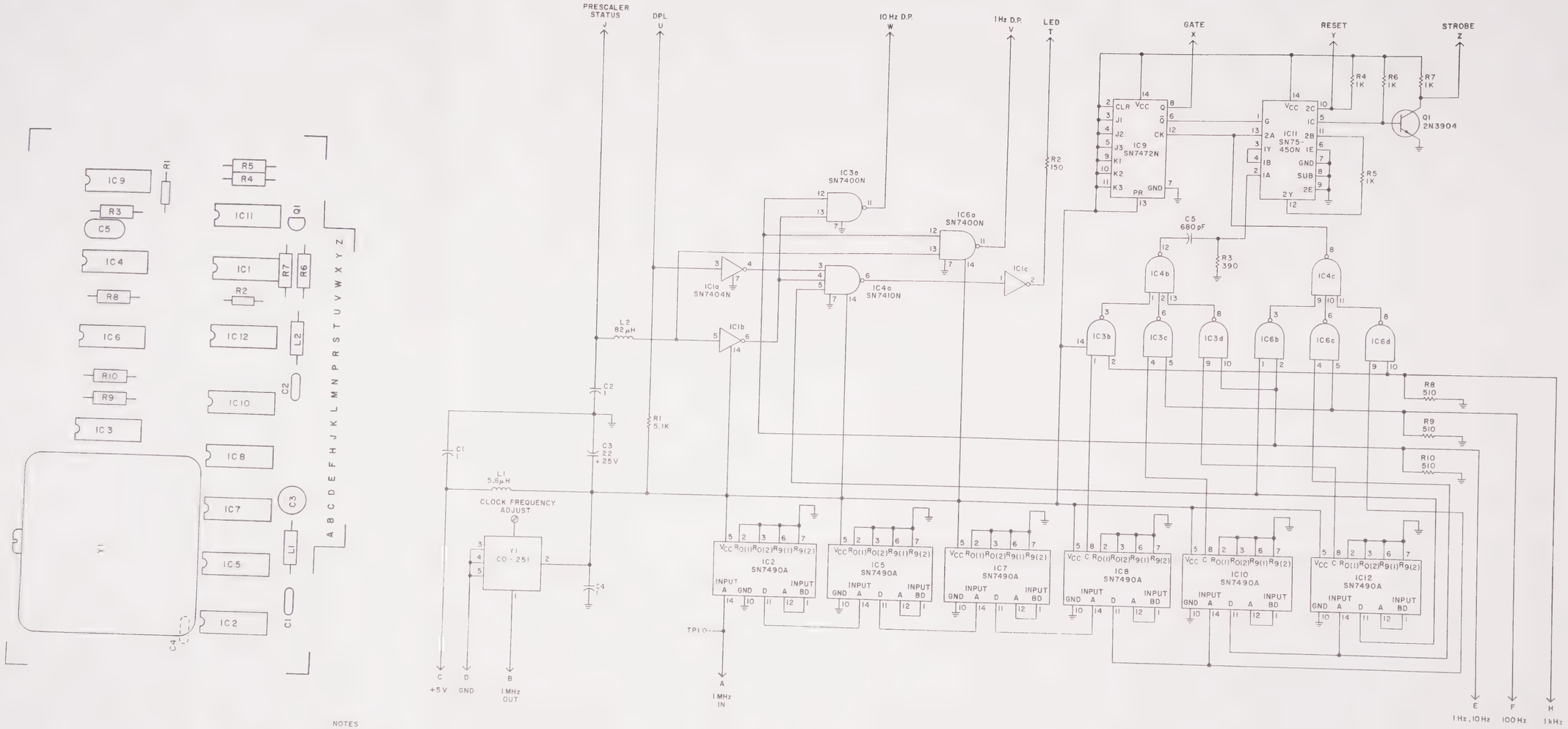
1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED: C15, R13, CR14
4. FOR 103A-51, 103B-51, 103C & 103D ONLY.



P1
CONNECTS TO J16 ON
A1 MAIN FRAME SCHEMATIC
830853, SHT. 1
AND ON
A1 MAIN FRAME SCHEMATIC
830903
AND ON
A1 MAIN FRAME SCHEMATIC
830991, SHT. 1
AND ON
A5 RF HOUSING SCHEMATIC
830992, SHT. 2
AND ON
A1 MAIN FRAME SCHEMATIC
830989, SHT. 1
AND ON
A1 MAIN FRAME SCHEMATIC
830990
AND ON
A42-1 MAIN FRAME SCHEMATIC
830883, SHT. 3
AND ON
A42-2 MAIN FRAME SCHEMATIC
830923

Figure 6-15. Power Supply PCB A14, Schematic Diagram

E830853D



NOTES

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED:
   R10, C5

P1 CONNECTS TO J16
ON A1 FRAME SCHEMATIC
830853 SHT. 1
AND ON
A1 MAIN FRAME SCHEMATIC
830903
AND ON
A1 MAIN FRAME SCHEMATIC
830991 SHT. 1
AND ON
A5 RF HOUSING SCHEMATIC
830992 SHT. 2
AND ON
A1 MAIN FRAME SCHEMATIC
830989 SHT. 1
AND ON
A1 MAIN FRAME SCHEMATIC
830990
AND ON
A42-1 MAIN FRAME SCHEMATIC
830883, SHT. 3
AND ON
A42-2 MAIN FRAME SCHEMATIC
830923

Figure 6-16. Display Time Base PCB A16, Schematic Diagram

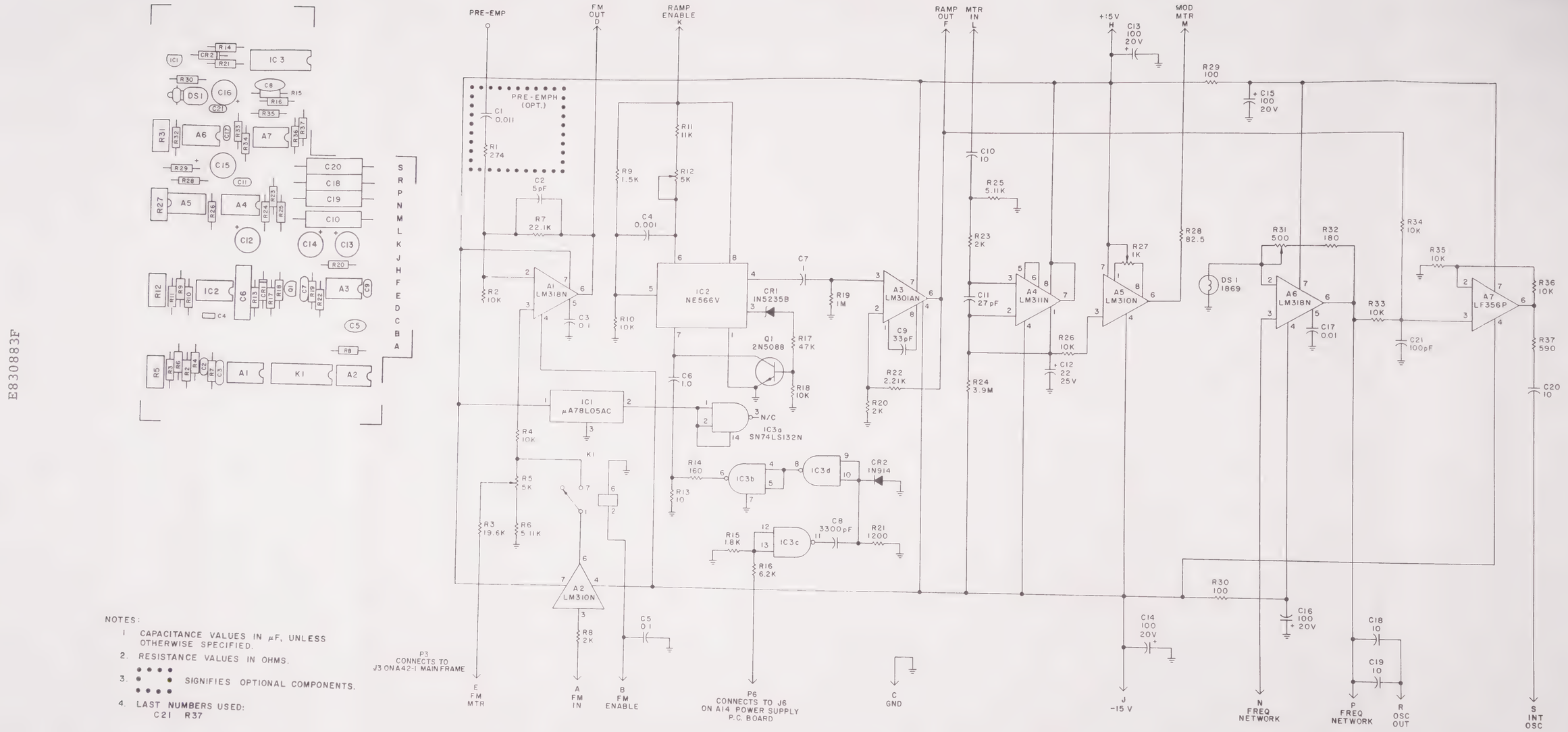
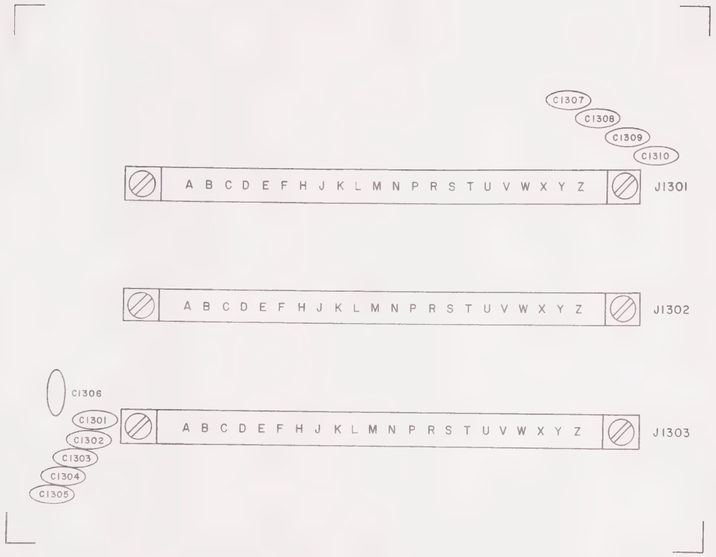
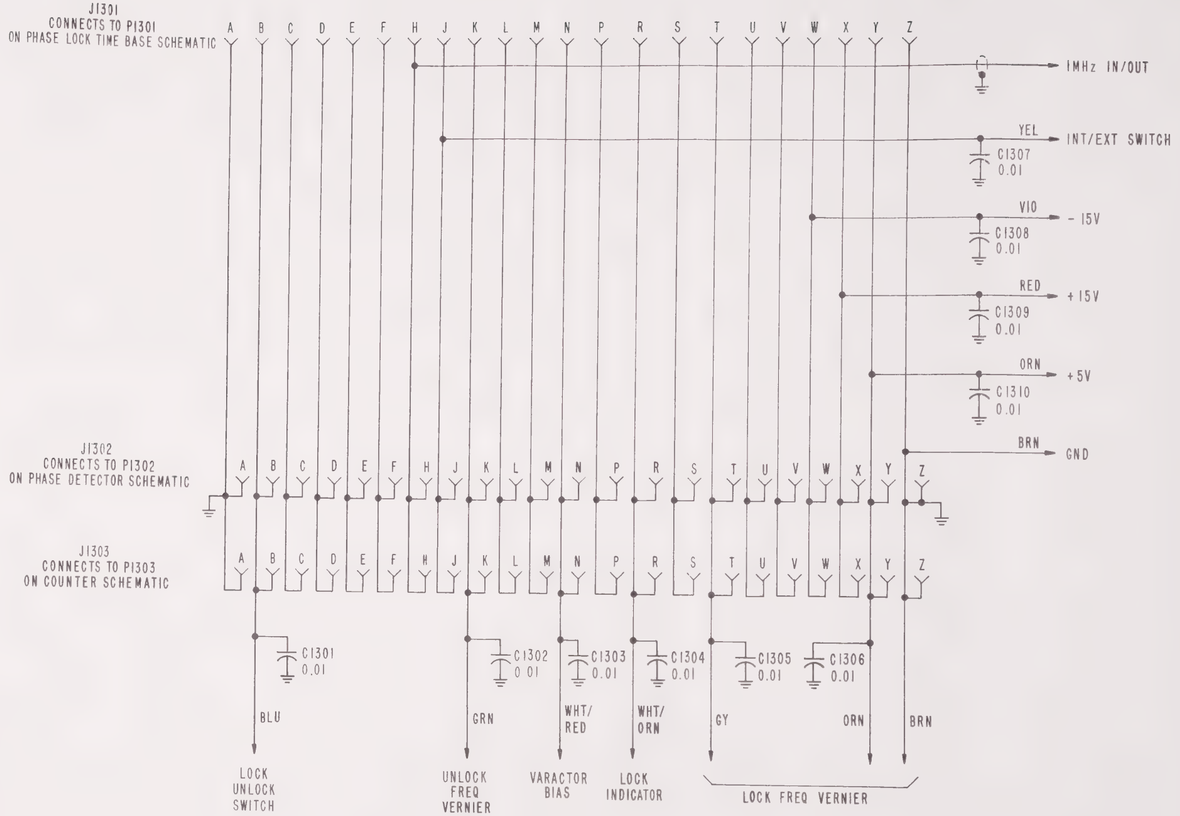


Figure 6-17. Modulation PCB A41, Schematic Diagram

D830744A


C1307
C1308
C1309
C1310
A B C D E F H J K L M N P R S T U V W X Y Z
J1301
A B C D E F H J K L M N P R S T U V W X Y Z
J1302
C1306
C1301
C1302
C1303
C1304
C1305
A B C D E F H J K L M N P R S T U V W X Y Z
J1303



NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. LAST NUMBER USED:
   C1310

Figure 6-18. Phase Lock Master PCB, Model 103D, Schematic Diagram

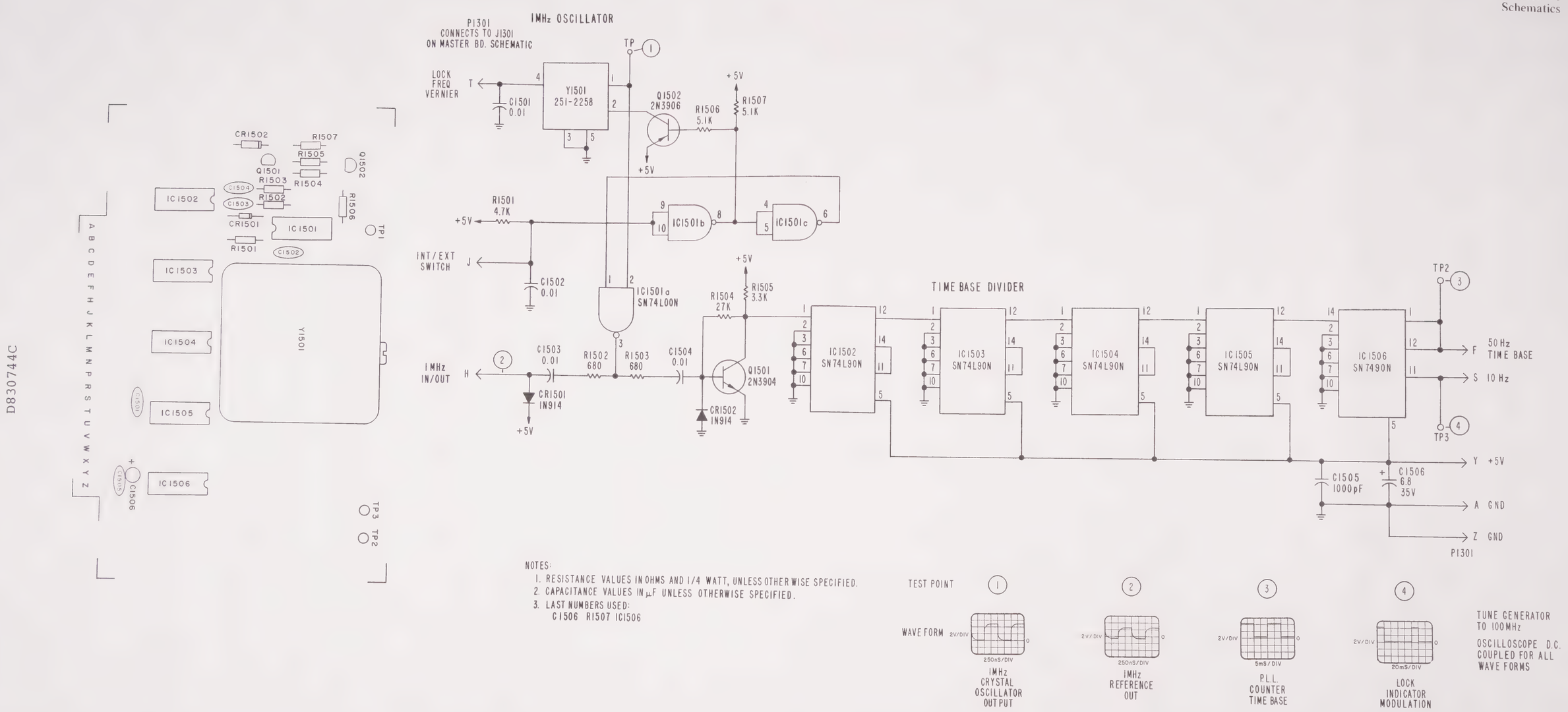
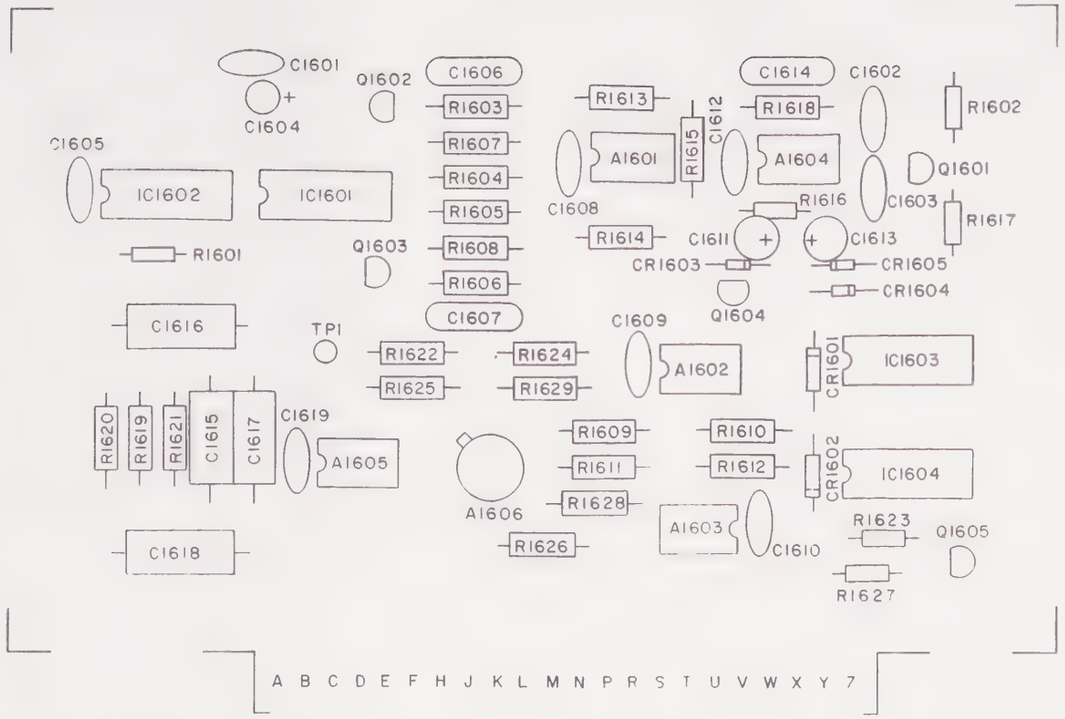


Figure 6-19. Phase Lock Time Base PCB, Model 103D, Schematic Diagram



E83-0744A

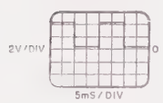
TESTPOINT

(1) LOAD PULSE TO PHASE DET.

WAVE FORM 2V/DIV

LOCKED MODE

(2) TIME BASE TO PHASE DET.



(3) DIFFERENTIAL AMP. OUTPUT

LOCKED MODE

NOTE
THIS WAVEFORM MAY BE POSITIVE OR NEGATIVE AND DC OFFSET WILL VARY FROM UNIT TO UNIT

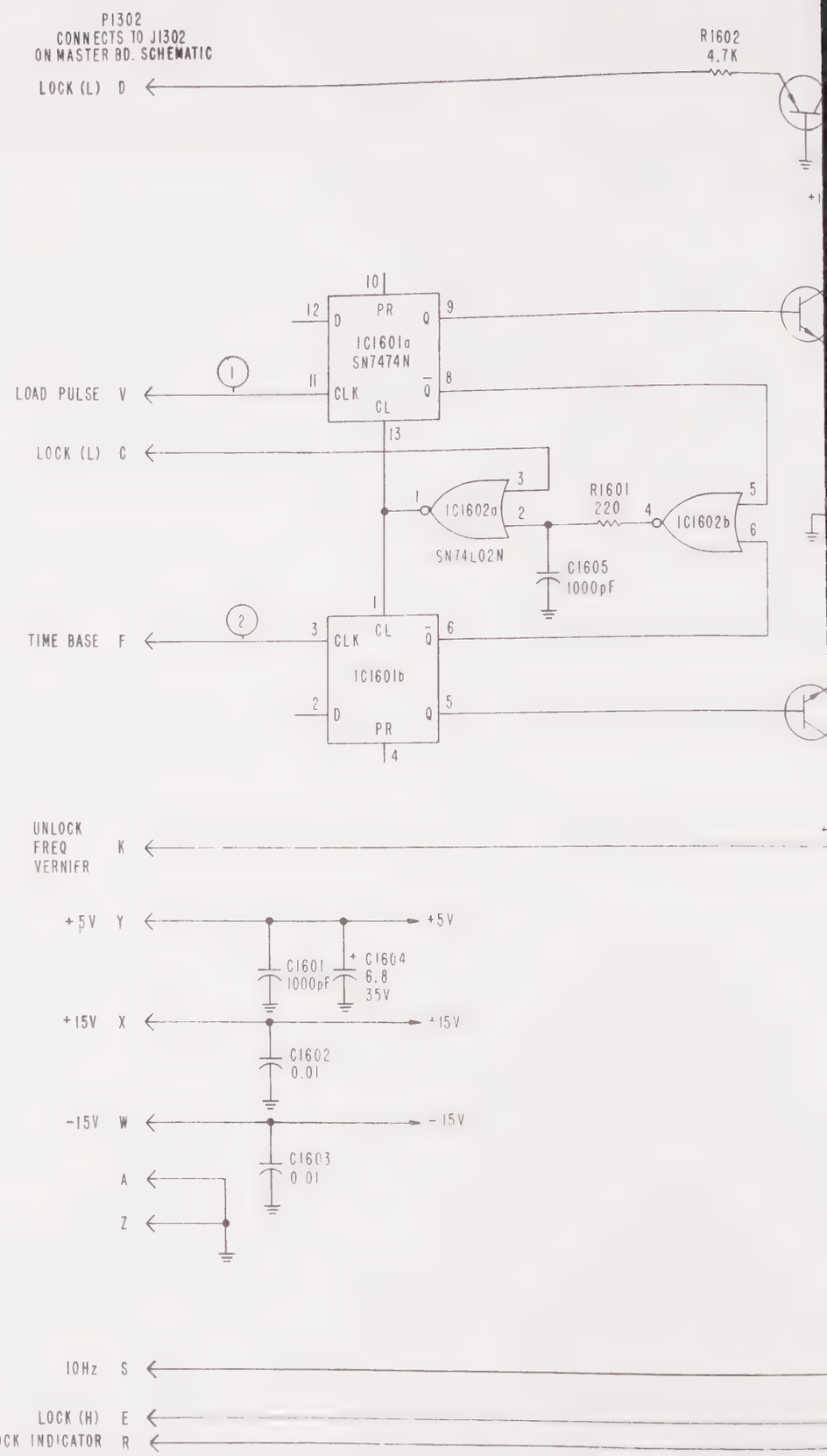
(4) LOCK INDICATOR MODULATION

TUNE GENERATOR TO 100MHz OSCILLOSCOPE D.C COUPLED FOR ALL WAVEFORMS

NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/4WATT, UNLESS OTHERWISE SPECIFIED
3. ✳ PRECISION RESISTOR, 3/8 WATT.
4. LAST NUMBERS USED:

C1619	R1629
A1606	CR1605
Q1605	IC1604



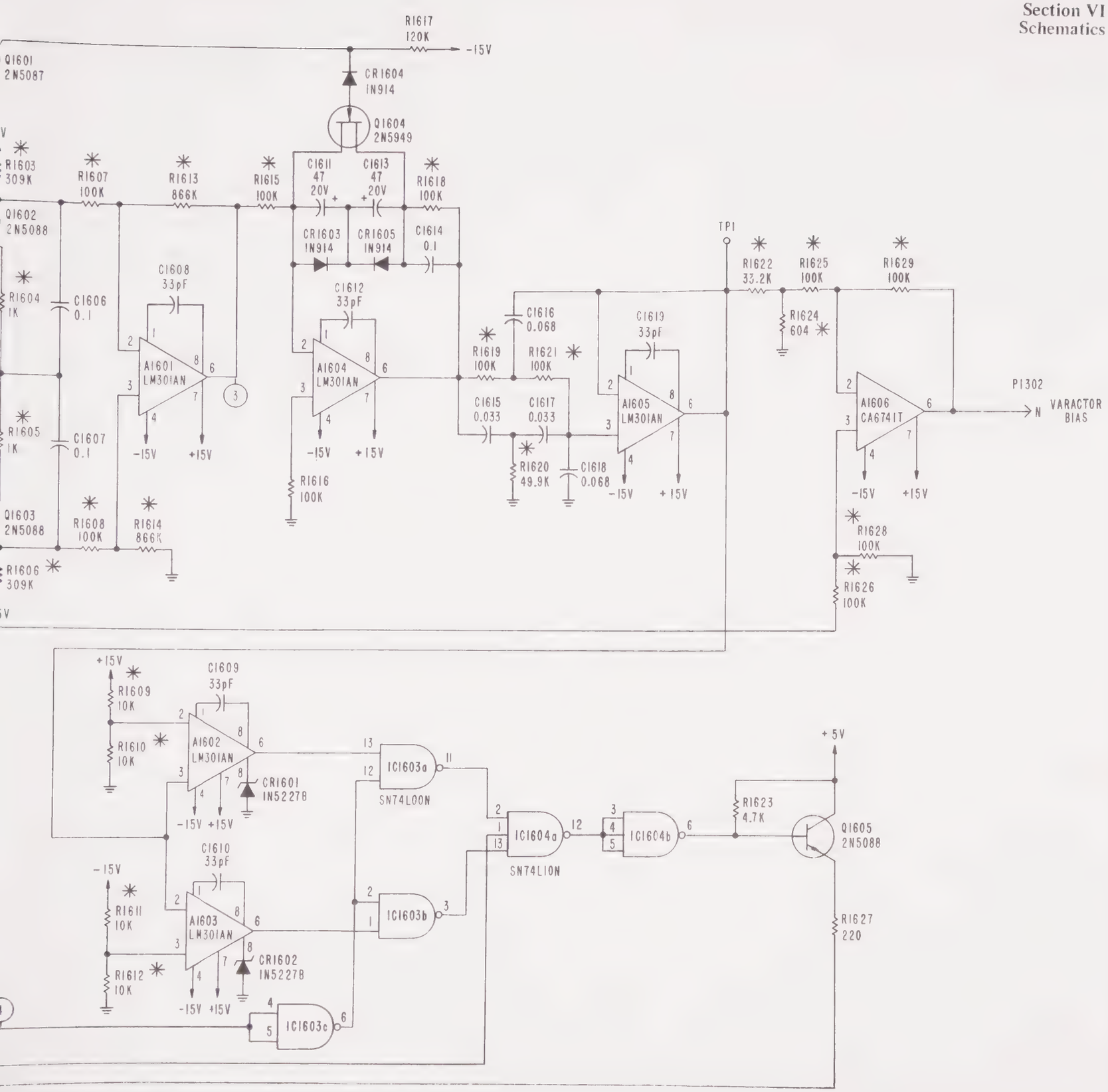


Figure 6-20. Phase Detector PCB, Model 103D, Schematic Diagram

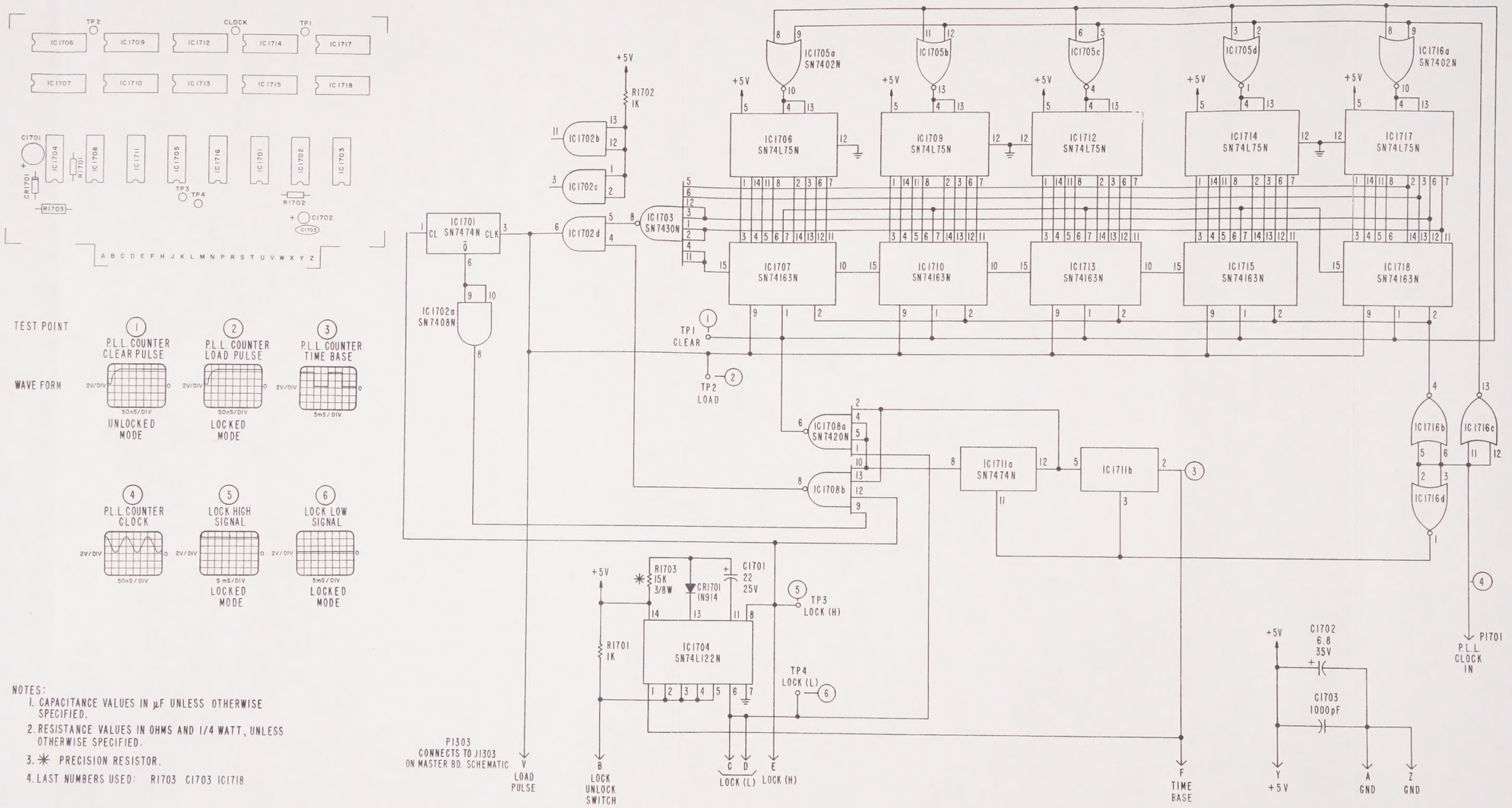


Figure 6-21. Phase Lock Counter PCB, Model 103D, Schematic Diagram

MP MASTER
MA24290